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Volume 2
(Maps)

TERRAIN STUDY OF THE ARMY TEST AREA, FORT GREELY, ALASKA

A contribution to Project 8-97-10-004
Military Evaluation of Geographic Areas

Prepared for:
Waterways Experiment Station
Corps of Engineers, U.S. Army
Vicksburg, Mississippi

By:
G. William Holmes and William S. Benninghoff,
Military Geology Branch
U. S. Geological Survey
Washington, D. C.

Based on field investigations by:
G. William Holmes, Daniel Sokol, and William S. Benninghoff,
Military Geology Branch, U.S. Geological Survey
Troy L. Péwé and Russell A. Paige, Alaskan Geology Branch,
U. S. Geological Survey

1957

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TERRAIN STUDY OF THE ARMY TEST AREA, FORT GREELY, ALASKA

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KAP

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- ✓ I-B Physiographic Provinces of Interior Alaska and Index to Maps of Fort Greely and Vicinity
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- ✓ I-D Boreal Vegetation
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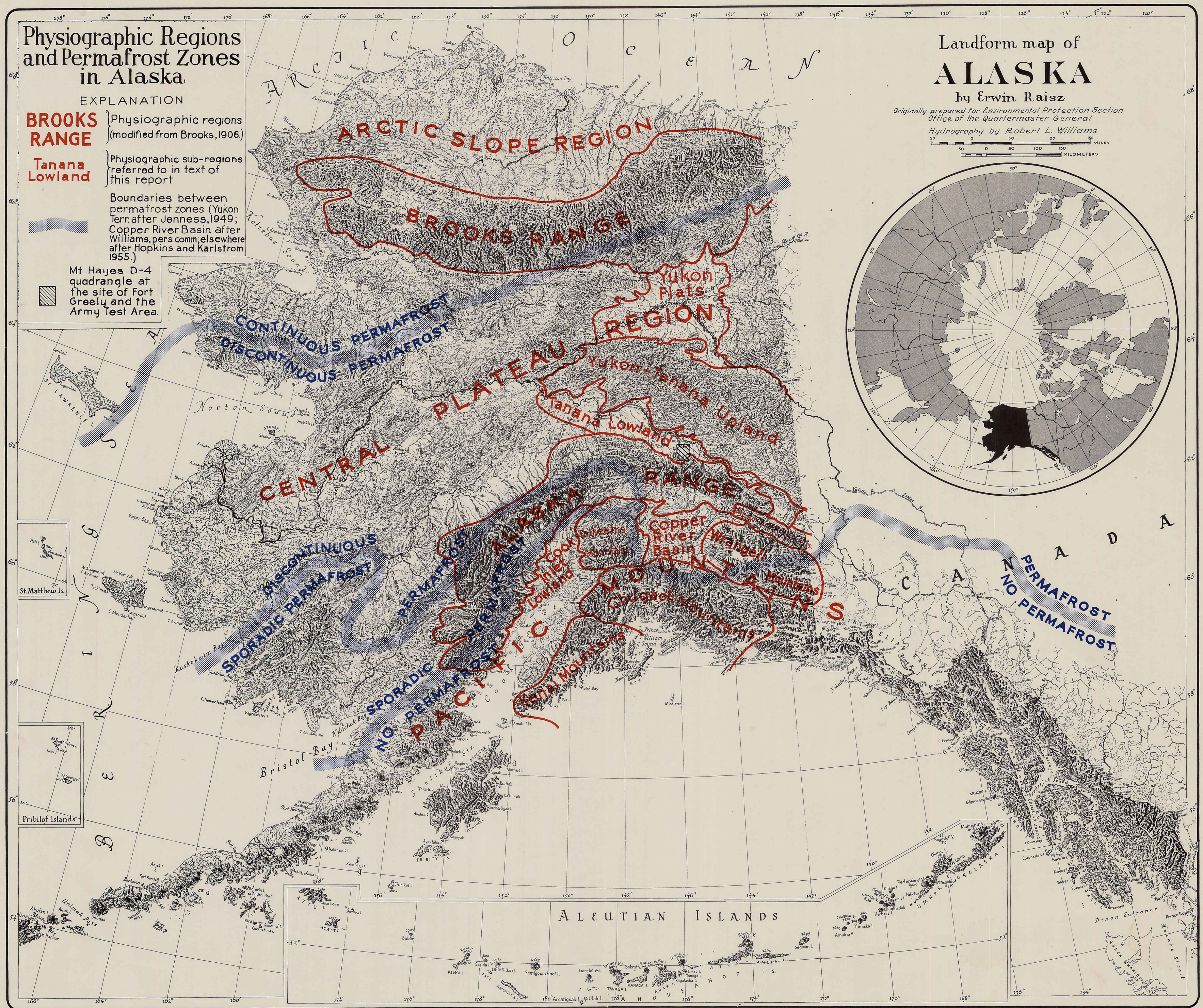
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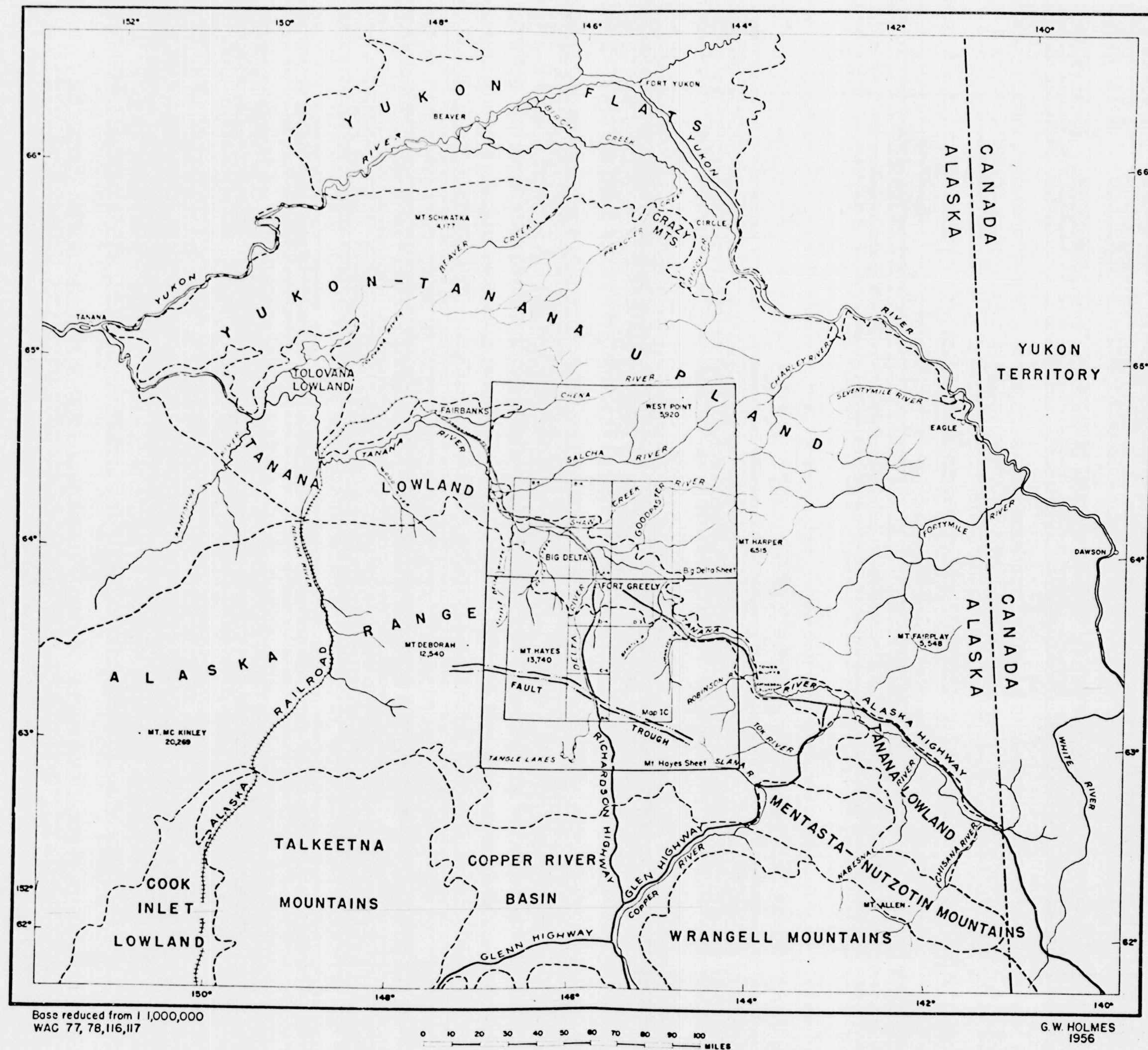
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1957

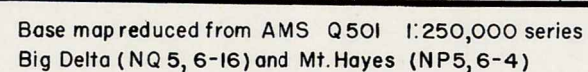


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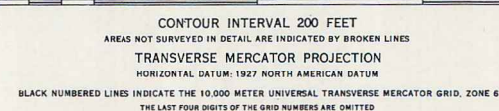
TERRAIN STUDY OF ARMY TEST AREA,
FORT GREELY, ALASKA
MAP I-B



PHYSIOGRAPHIC PROVINCES OF INTERIOR ALASKA
AND INDEX TO MAPS OF FORT GREELY AND VICINITY



G.W. Holmes





PRINCIPAL SOURCES

Brookman-Jerosch, H., (1932 ?),
Vegetation der Erde, 1:20,000,000
Justus Perthes, Gotha.

Sochava, V.B., 1954, Geobotanical map
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4th ed., 293 p., illus., map.

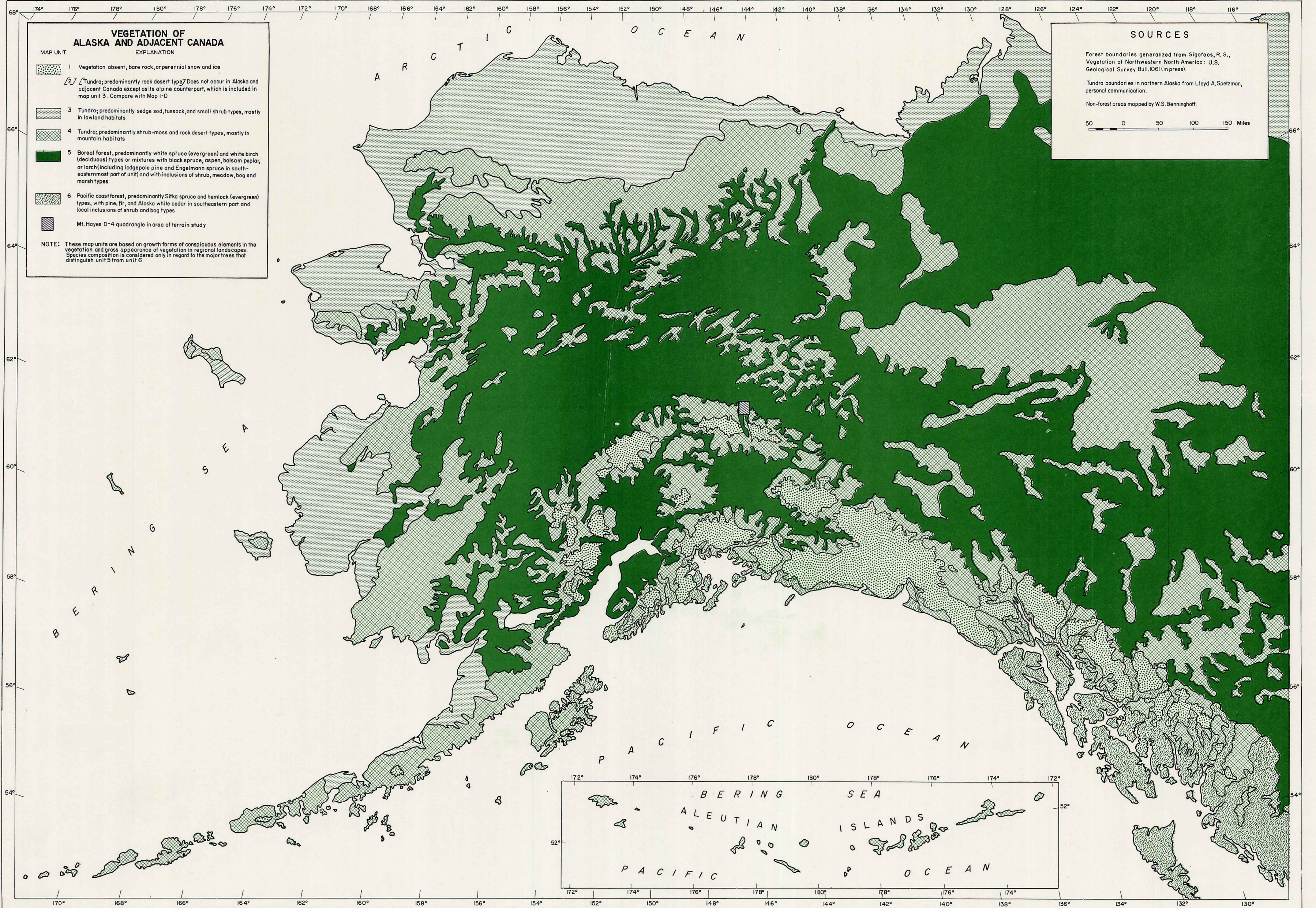
Sigafos, R.S., (in press), Vegetation of
northwestern North America
U.S. Geol. Survey Bull. 1061.

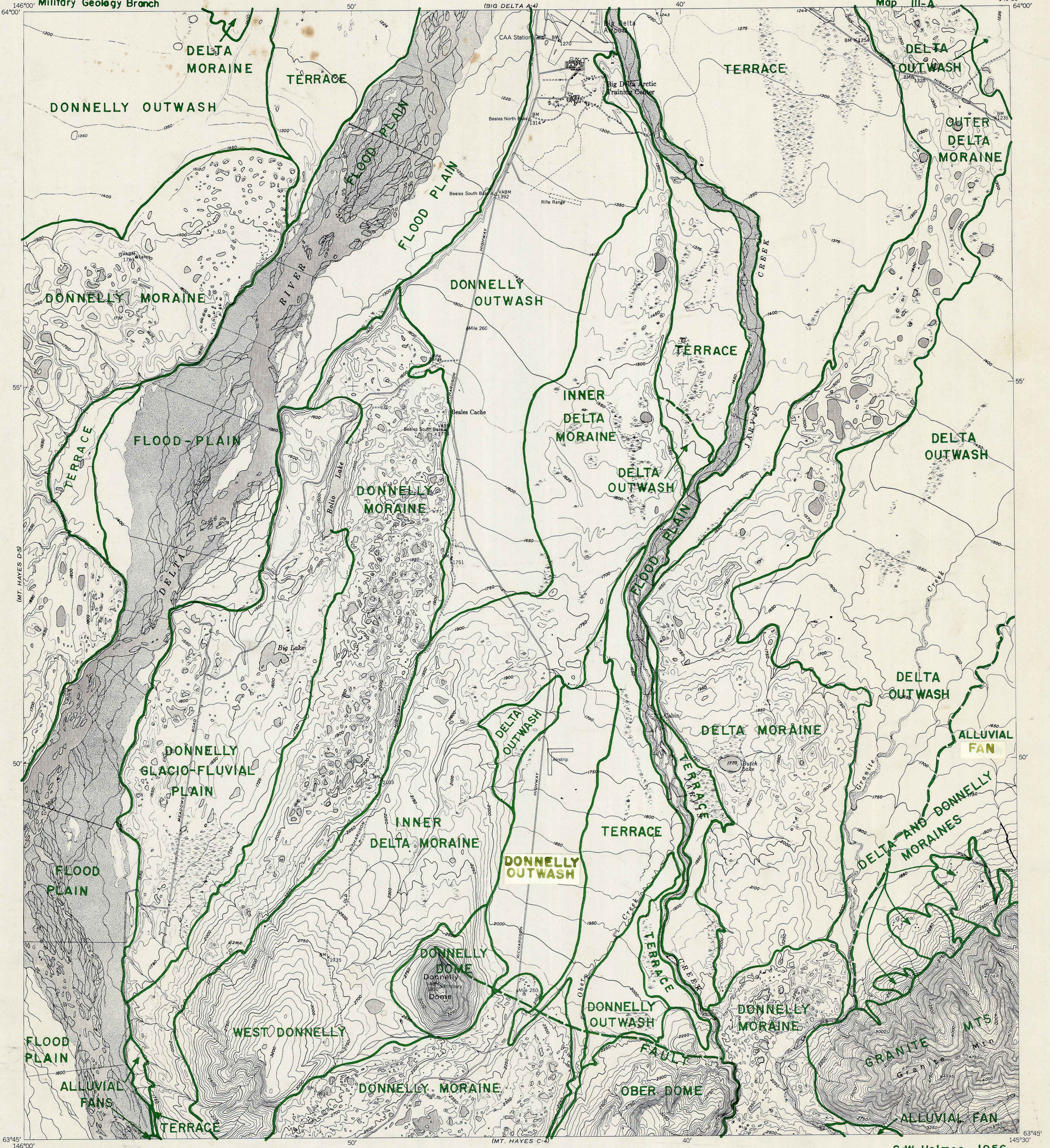
BOREAL VEGETATION

- 1 Vegetation absent; perennial snow and ice
- 2 Tundra; predominantly rock desert type
- 3 Tundra; predominantly sedge sod, tussock, and small shrub types of lowland habitats
- 4 Tundra; predominantly shrub-moss and rock desert types of mountain habitats
- 5 Boreal forest; evergreen, mixed, deciduous forest types and inclusions of shrub, meadow, bog, and marsh types

Approximate southern limit of continuous boreal forest
(i.e. the northern belt of coniferous forest, in
which species of spruce, fir, pine, or larch and
birch or poplar are dominant)

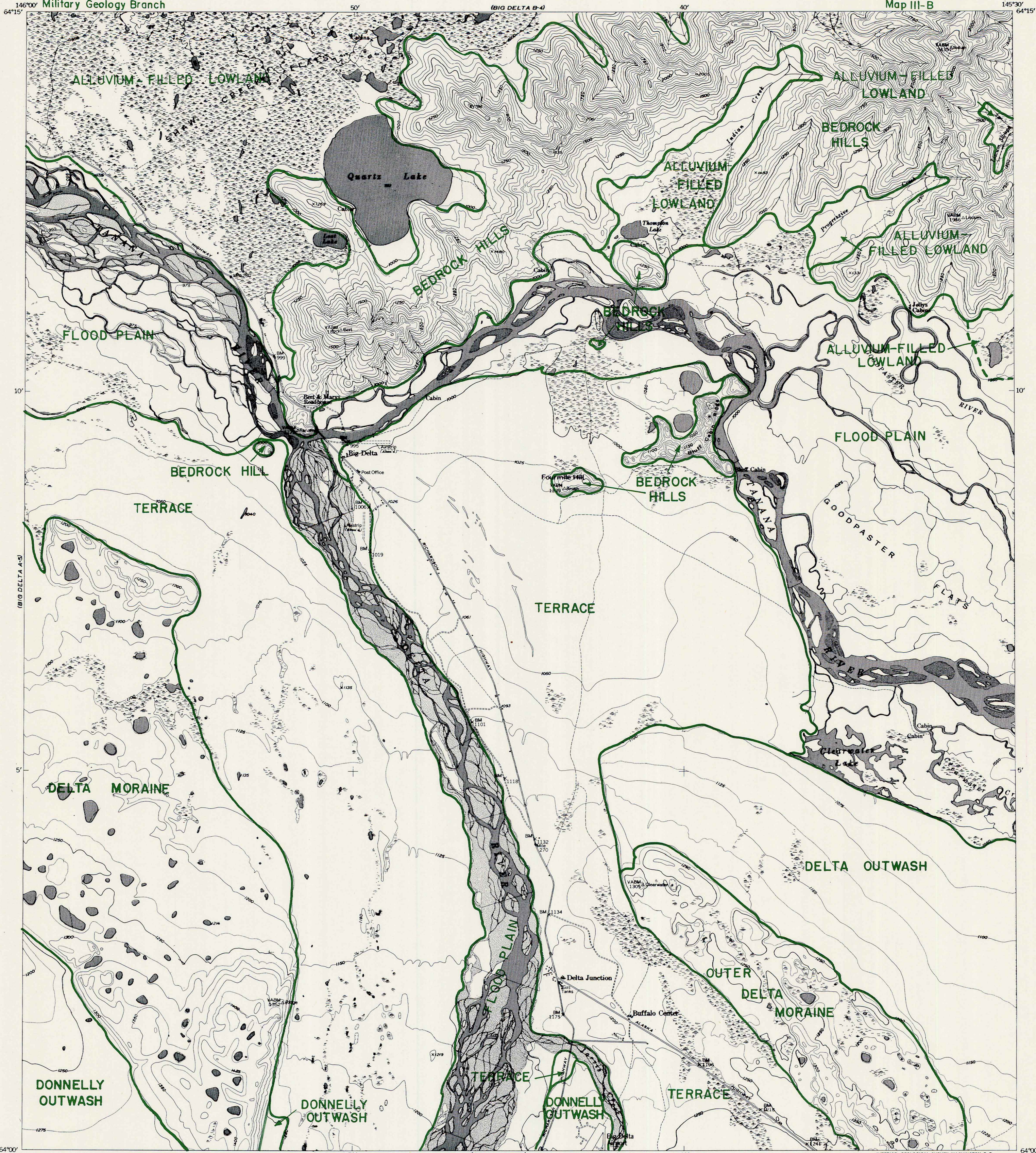
NOTE: These map units are based on growth forms of conspicuous
elements in the vegetation and gross appearance of
vegetation in regional landscapes. Species composition
is not considered in this scheme.





MAJOR LANDFORMS OF THE MT. HAYES D-4 QUADRANGLE

G.W. Holmes, 1956



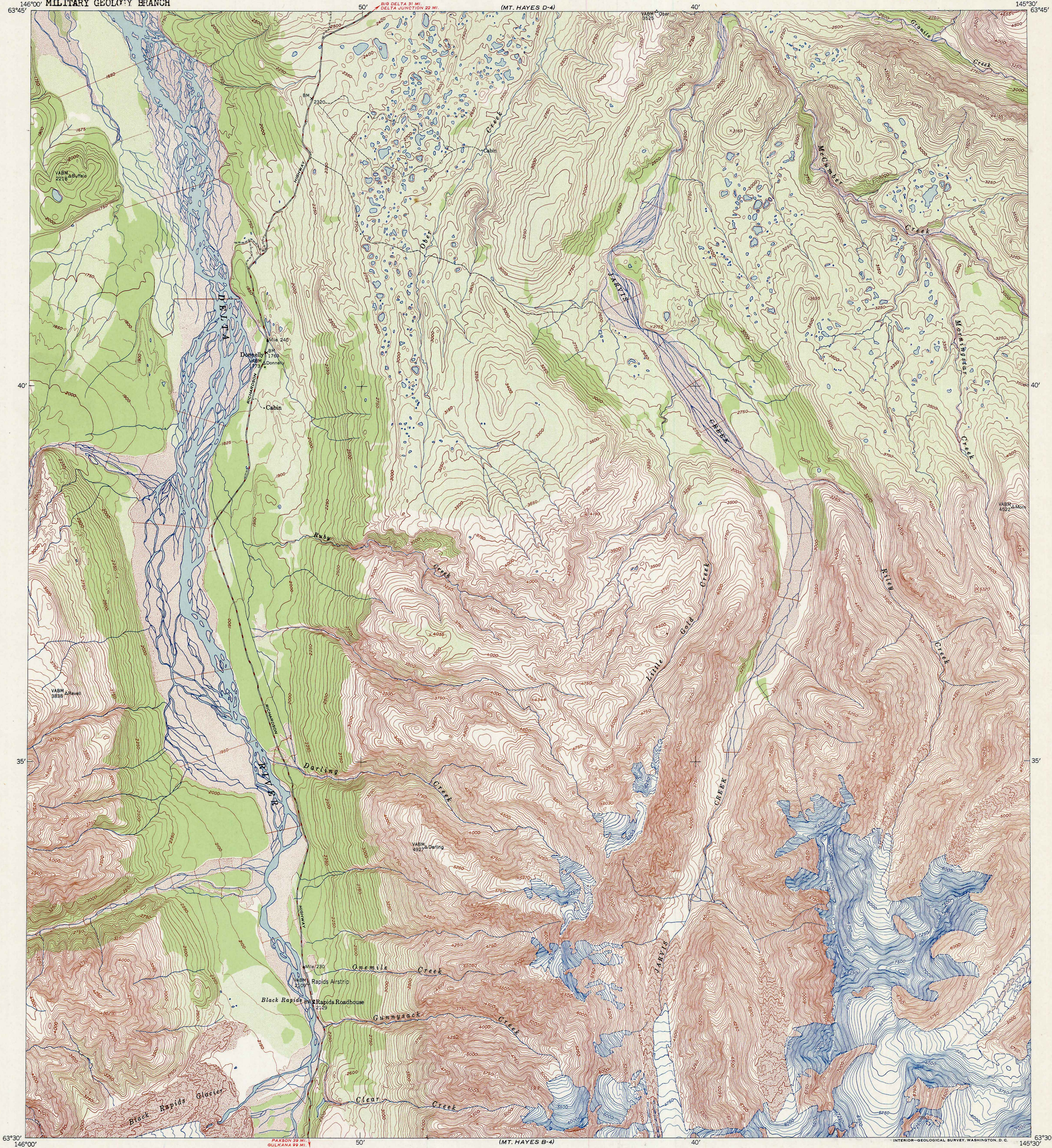
MAJOR LANDFORMS OF THE BIG DELTA A-4 QUADRANGLE

SCALE 1:63360
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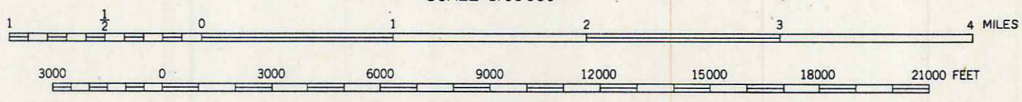
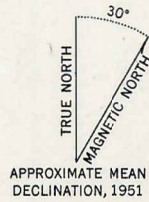
MT. HAYES D-3

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TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-C
MT. HAYES (C-4) QUADRANGLE
ALASKA-FOURTH JUDICIAL DIVISION
1:63 360 SERIES (TOPOGRAPHIC)



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Aerial photographs taken August 1949
Universal Transverse Mercator projection, zone 6
1927 North American datum
Unchecked elevations shown in brown and blue



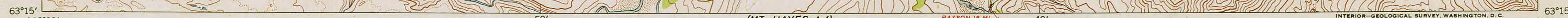
CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL
TOPOGRAPHIC MAP

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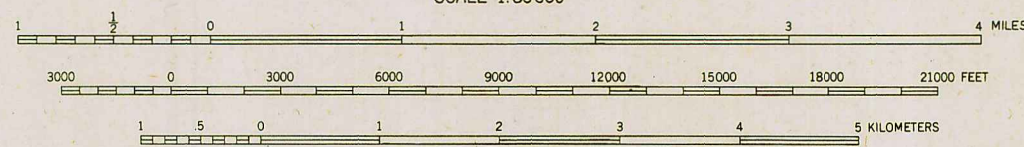
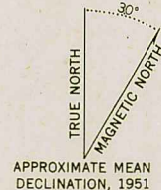
ROAD CLASSIFICATION
ALL WEATHER ROADS DRY WEATHER ROADS
Hard-surface None Improved dirt None
Other - - - - - Unimproved dirt - - - - -
Trails - - - - -

MT. HAYES (C-4), ALASKA
N6330-W14530/15X30

EDITION OF 1952



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Aerial photographs taken September 1948 and August 1949
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1927 North American datum
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DATE IS MEAN SEA LEVEL
TOPOGRAPHIC MAP

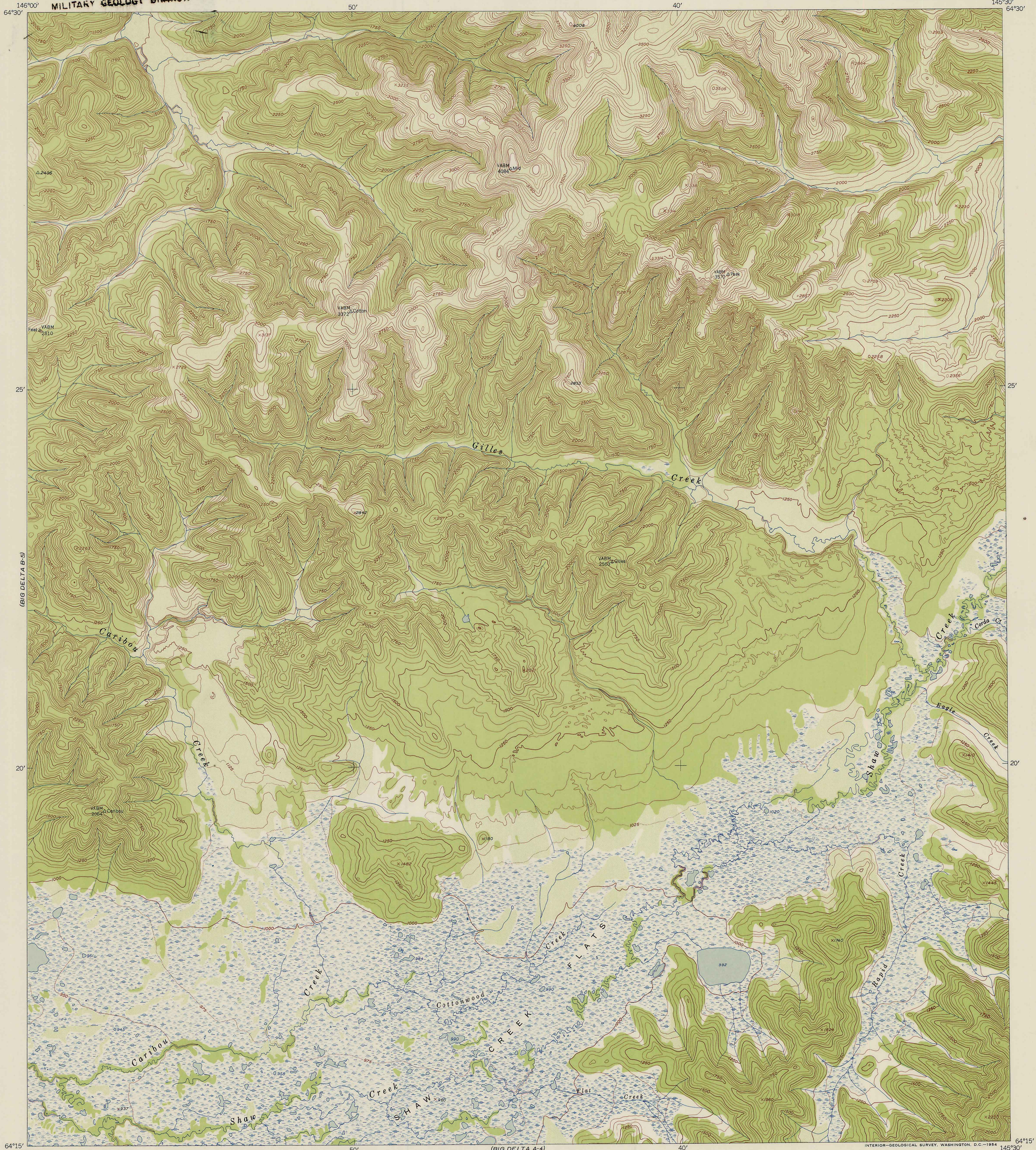
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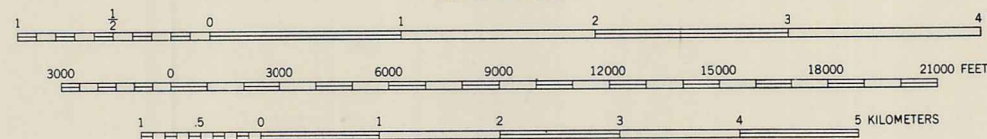
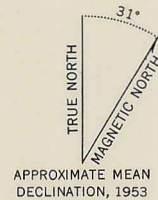
ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface.....	None	Improved dirt.....	None
Other.....	- -	Unimproved dirt.....	=====
Trails.....		None	

MT. HAYES (B-4), ALASKA
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ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface	None	Improved dirt	None
Other	None	Unimproved dirt	None
		Trails	None

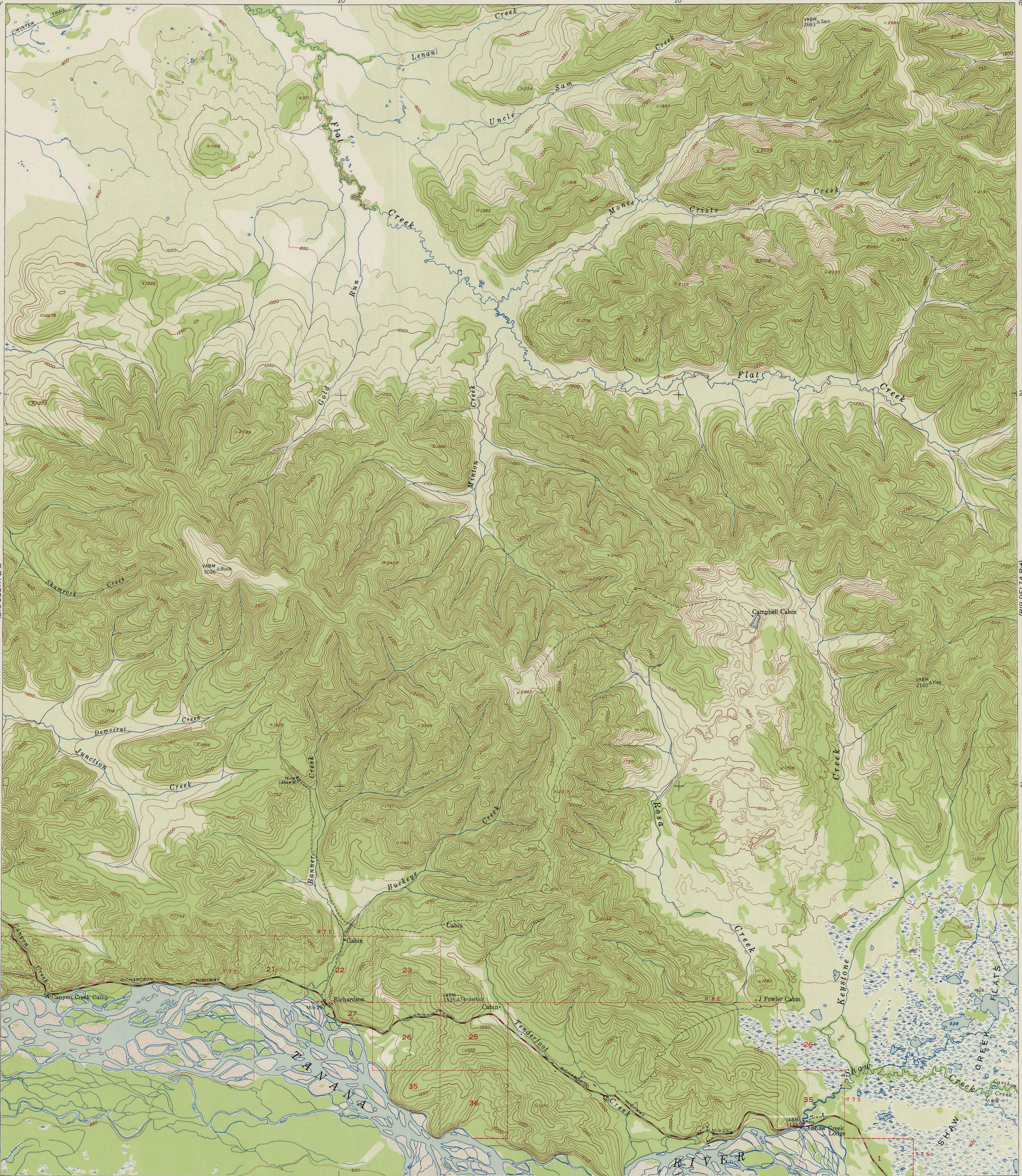
BIG DELTA (B-4), ALASKA
N6415-W14530/15X30

1953

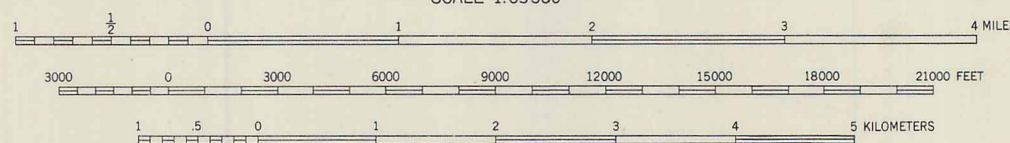
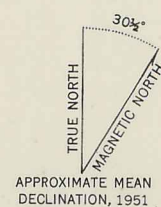
TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-T

BIG DELTA (B-5) QUADRANGLE
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Unchecked elevations shown in brown and blue



TOPOGRAPHIC MAP

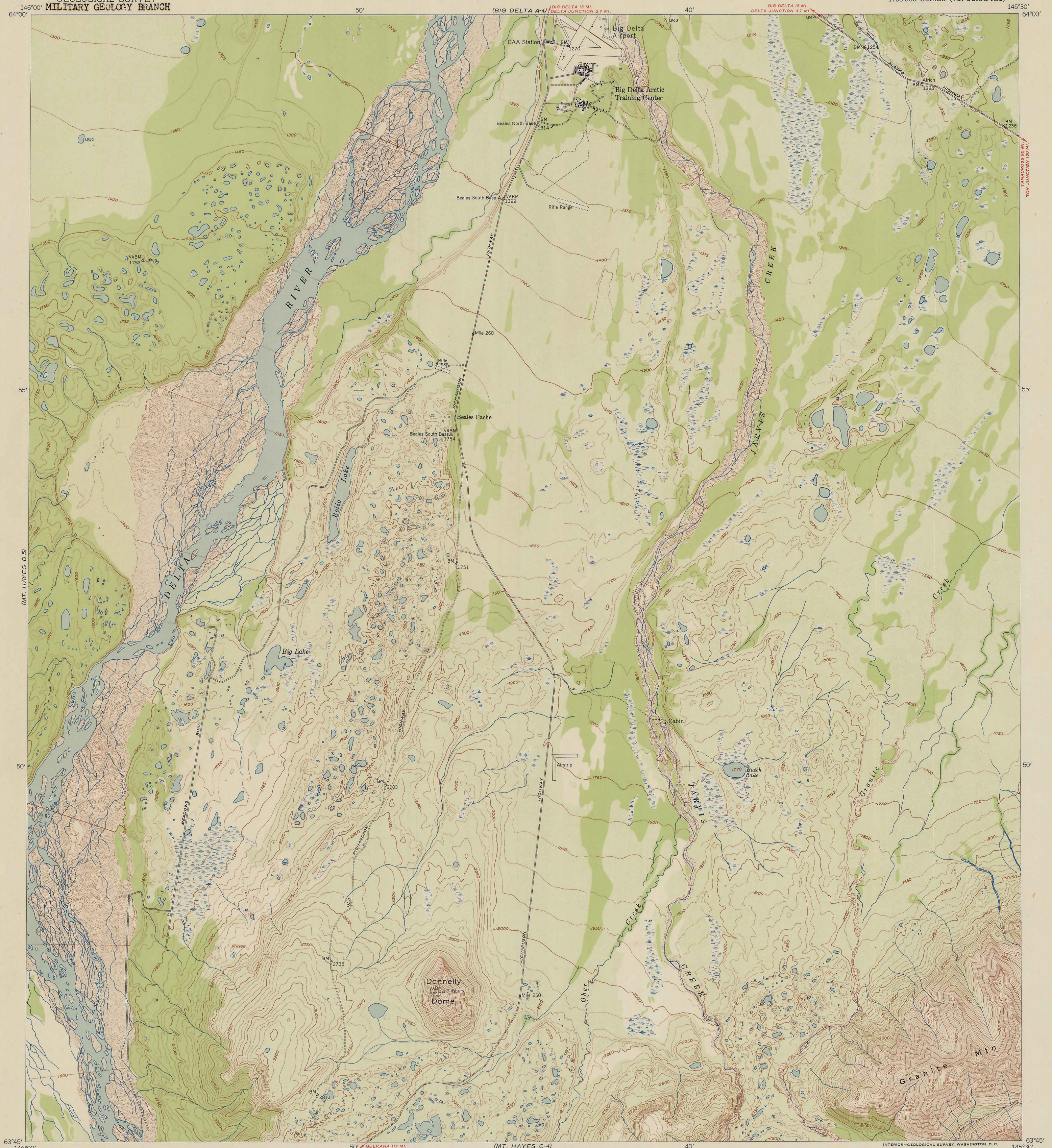
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ROAD CLASSIFICATION
ALL WEATHER ROADS DRY WEATHER ROADS
Hard-surface..... Improved dirt..... None
Other..... None Unimproved dirt.....
Trails.....

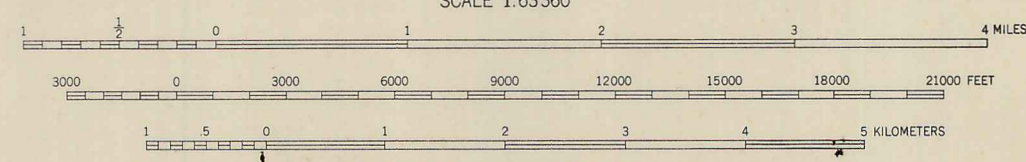
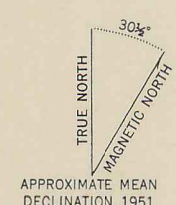
BIG DELTA (B-5), ALASKA
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1949

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CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL
TOPOGRAPHIC MAP

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ROAD CLASSIFICATION

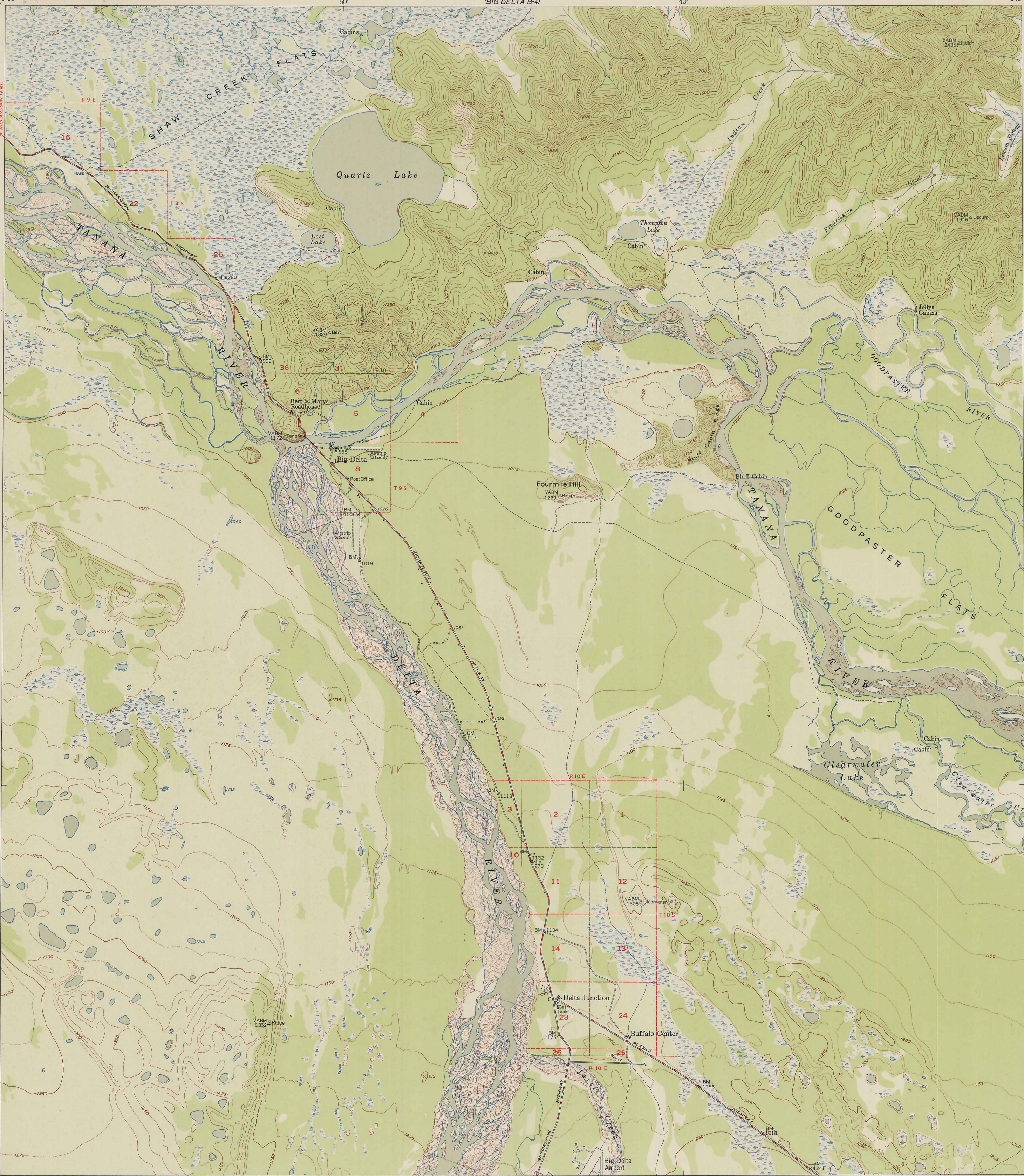
ALL WEATHER ROADS	DRY WEATHER ROADS
Hard-surface.....None	Improved dirt.....
Other.....	Unimproved dirt.....
	Trails.....

MT HAYES (D-4), ALASKA
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EDITION OF 1952

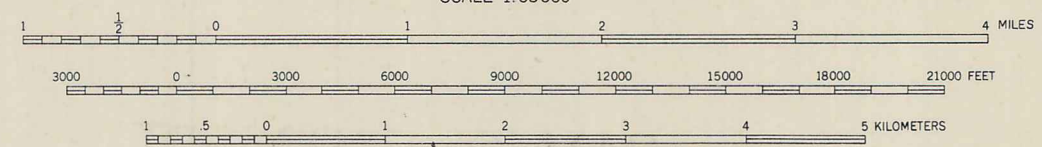
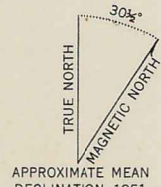
TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-H

BIG DELTA (A-4) QUADRANGLE
ALASKA-FOURTH JUDICIAL DIVISION
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ROAD CLASSIFICATION
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Hard-surface Improved dirt
Other Unimproved dirt
Trails

BIG DELTA (A-4), ALASKA
N6400-W14530/15X30

EDITION OF 1952



Gravel, talus, rubble, outwash, sand, bedrock. Non-frost-susceptible. Permafrost table low, and/or permafrost does not affect surface or stability. Except where slope and roughness are limiting factors, these miscellaneous units are good to excellent for cross-country movement in summer; good to excellent for foundations for airfields, roads and buildings (except flood plains). Little or no seasonal variations in moisture and strength as far as engineering and military aspects are concerned.

Qmm	Qmt
Qmh	Ql

Q1, Lake silt (ML) in drained lake basins. No micro-relief; no peat. Permafrost more than 3 feet below surface.

Qdesk, Donnelly outwash
esker gravel on Qdoor.

Qdfo

Qdto, Delta outwash. Aprons
attached to Delta moraines.
2 to 13 feet of silt (ML)
over GP, or rarely GW or
SW-SM.

Qdts, Delta till, mantled by
eolian silt and solifluction
deposits on the west slope of
West Donnelly.

Clay, sand, shale, coal, and conglomerate.


Crystalline bedrock:
grano-diorite in the Granite Range;
Birch Creek schist on Ober Dome,
Donnelly Dome, and West Donnelly.


Lithologic Data Model

Mantle —————
Underlying
unconsolidated material —————

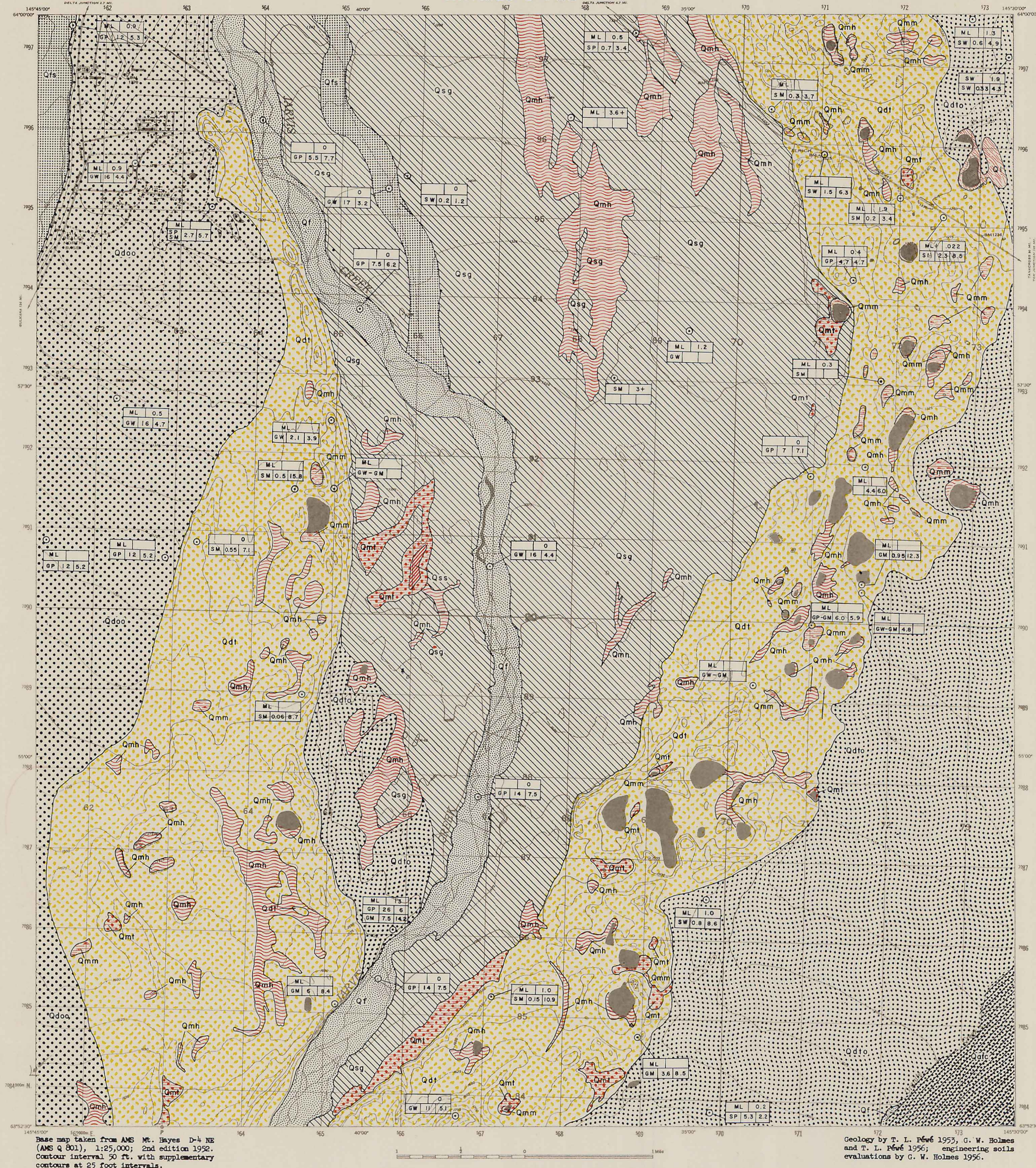
Classification		Thickness
Classification	Median size (mm)	Sorting coefficient

Symbols

 Terrace scarp

 Transitional contact

 Fault



GEOLOGY AND SOILS

Summary and General Evaluations

Silt and silty-sand, 2 or more feet thick. Frost-susceptible with shallow permafrost table, commonly 2 to 4 feet deep. Poor surface for cross-country movement in summer; poor for roads, airfields and foundations. Marked seasonal changes in soil moisture and strength.

Till. Sandy and gravelly; generally frost-susceptible, but locally non-frost susceptible. Permafrost table usually 3 or more feet below surface. Silt mantle ranges from 0 to more than 3 feet thick. Fair to poor for cross-country movement in summer; fair to good for roads and foundations. Topography normally too rough for airfields. Moderate to minor seasonal variations in soil moisture and strength.

Gravel, talus, rubble, outwash, sand, bedrock. Non-frost-susceptible. Permafrost table low, and/or permafrost does not affect surface or stability. Except where slope and roughness are limiting factors, these miscellaneous units are good to excellent for cross-country movement in summer; good to excellent for foundations for airfields, roads and buildings (except flood plains). Little or no seasonal variations in moisture and strength as far as engineering and military aspects are concerned.

Quaternary Deposits, Undifferentiated as to Age, Resting on Glacial and Alluvial Deposits and on Bedrock



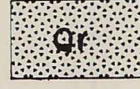
Qc, Solifluction deposits: silt and rock fragments. Mantles Delta till or bedrock hills. Solifluction deposits on bedrock hills are a mixture of angular frost-riven schist or granite; on till, similar to till, but contain more silt and are more well-sorted (poorly sorted). SM. In festoons, lobes, or poorly defined terraces.



Qt, Talus. Angular boulders and smaller fragments of bedrock in fans and sheets on cirque walls and canyon sides. Large talus fans only in Granite Range.



Qd, Dune sand, mantled by silt. Medium and coarse poorly graded (well sorted) sand. SW and SP. In low sand sheets or composite dunes and sand hills, 6-20 feet thick. Sand dune field on west side of Delta River is pocked by sub-parallel depressions.



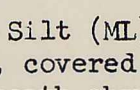
Qr, Rubble. Angular boulders and smaller fragments of bedrock resting on flat and gently inclined upland surfaces, e.g., summits of Granite Mts. or Ober Dome.



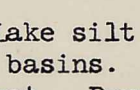
Qmm, Silt (ML) overlain by peat and marsh vegetation. Peat up to 0.5 foot thick, usually covered by standing water in summer. Permafrost 3 or more feet below peat; no micro-relief features.



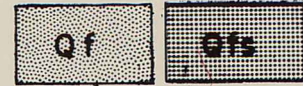
Qmt, Silt (ML) overlain by peat and sedge tussocks. Peat typically 0.5 foot thick between tussocks which are commonly surrounded by water in summer. Tussocks are 1-2 feet high and 1 foot in diameter. Permafrost 2-3 feet below peat.



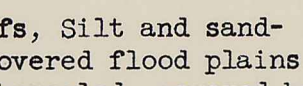
Qmh, Silt (ML) overlain by peat, covered by moss, sedge, and heath shrub; forming hummocks 1-2 feet high and 2-5 feet in diameter. Peat up to 1.0 foot thick.



Ql, Lake silt (ML) in drained lake basins. No micro-relief; no peat. Permafrost more than 3 feet below surface.



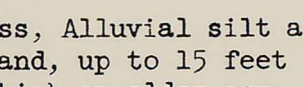
Qf, Flood plain gravel and sand of bare braided flood plains of glacial streams and Granite Creek. GP and GW.



Qfs, Silt and sand-covered flood plains. Channeled, covered by forest or shrub. Sand and silt 1-3 feet thick, with shallow permafrost in places. SW and SP covering GW or GP.



Qsg, Alluvial silt and sand, 2 to more than 14 feet thick, covering gravel. In younger composite terrace 3 to 8 feet above the flood plain. Permafrost in places 3 to 4 feet below surface. ML covering GW or GP.



Qss, Alluvial silt and sand, up to 15 feet thick on older composite terrace. 15 to 25 feet above flood plain. ML covering GW or GP.



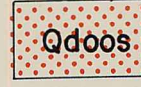
Qab, Boulderly gravel. Rounded boulders 5 or more feet in diameter in coarse sand and pebble matrix, forming boulder terrace. Surface is littered with boulders, and is channeled. Terrace rises in irregular flights to about 45 feet above flood plain. Matrix is GP.



Qaf, Alluvial fan. Sand, silt, and gravel. Silt cover up to 18 feet thick. Deeply gullied, and truncated. ML over GW or GP.



Qafc, Alluvial sand and gravel from alluvial and glacial sources. SW on GW or GP.



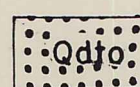
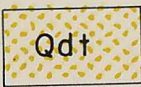
Qdoot, Donnelly till. Slightly weathered, gray to yellowish sandy till with rounded and angular rock fragments. Permafrost probably 10 or more feet below surface. Mantled by 0 to 3 feet of eolian silt. Moraines are rough, with numerous kettle depressions and few bogs. 100 or more feet thick in frontal sectors. Mostly SM plus GW, GP and GM, with ML cover.

Qdoor, Donnelly outwash recessional phase. Silt-covered, channeled, and in places thinly mantled by till. ML covering GP, GW or SP-SM.

Qdoob, Donnelly outwash bare of silt or with silt mantle less than 0.3 foot. GW and GP.

Qdoots, Donnelly outwash with thick silt and organic silt mantle, estimated to be 10 or more feet thick. Frozen at 1 to 2 feet. ML over GP or GW.

Qdesk, Donnelly outwash esker gravel on Qdoor.



Qdt, Delta till. Moderately weathered yellowish sandy till with angular and rounded rock fragments. Rolling moraines with a few ponds and many bogs. Silt cover 0-1.8 feet. ML covering GM, SM, GW-GM, and other sand and gravel soils.

Qdtf, Delta till, with frost scars; pits 1 foot deep, 2-5 feet in diameter on north slope of West Donnelly. Permafrost shallow. Associated with congeliturbate and solifluction lobes.

Qdts, Delta till, mantled by eolian silt and solifluction deposits on the west slope of West Donnelly.

Qdto, Delta outwash. Aprons attached to Delta moraines. 2 to 13 feet of silt (ML) over GP, or rarely GW or SW-SM.

T

Clay, sand, shale, coal, and conglomerate.



Crystalline bedrock: grano-diorite in the Granite Range; Birch Creek schist on Ober Dome, Donnelly Dome, and West Donnelly.

Sample location

Lithologic Data Model

	Classification		Thickness
	Classification	Median size (mm)	Sorting coefficient
Mantle			
Underlying unconsolidated material			

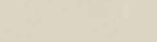
Symbols



Terrace scarp



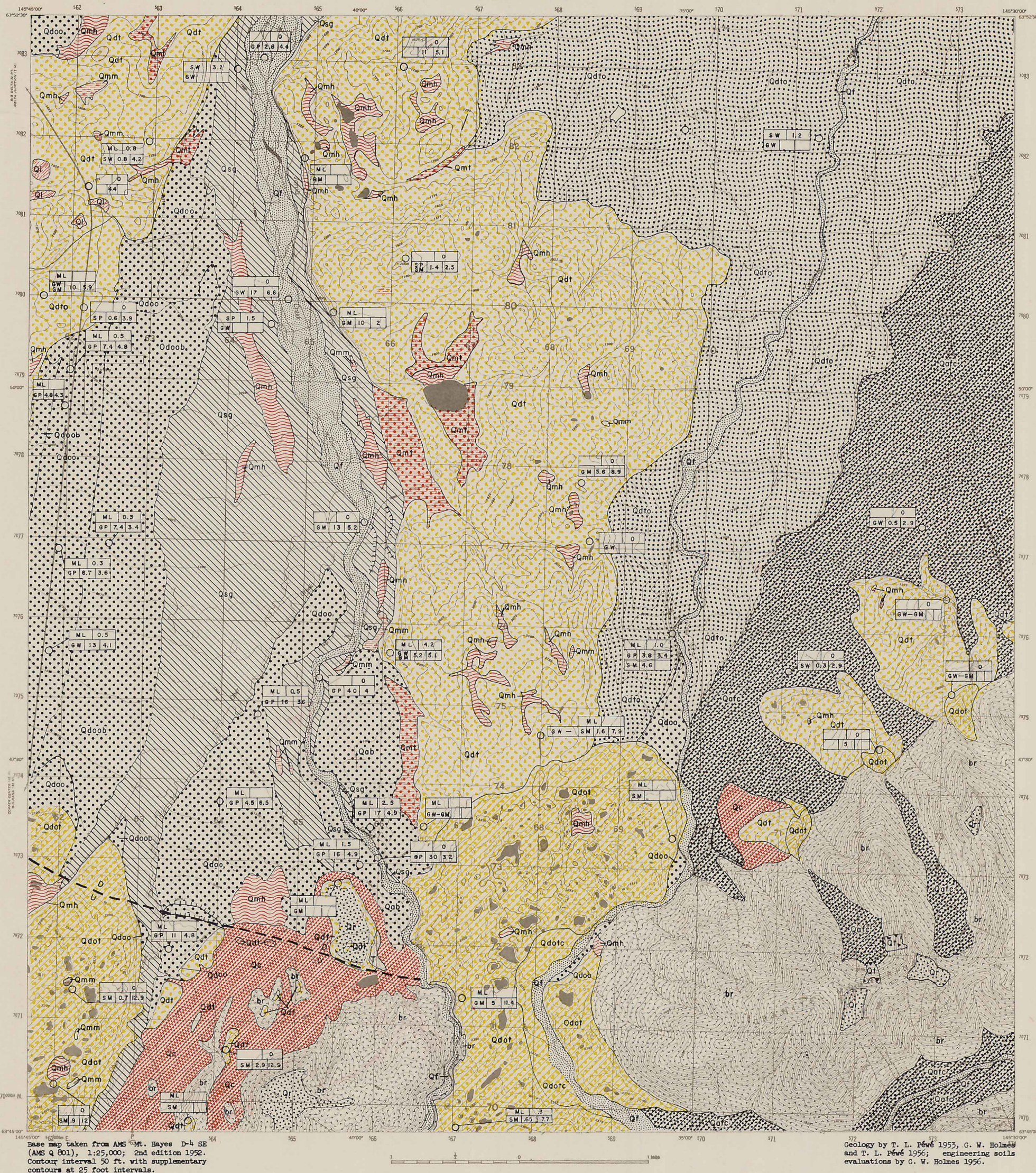
Transitional contact



Fault

GEOLOGY AND SOILS
MT. HAYES D-4 SE

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IV-C



GEOLOGY AND SOILS

Summary and General Evaluations

Silt and silty-sand, 2 or more feet thick. Frost-susceptible with shallow permafrost table, commonly 2 to 4 feet deep. Poor surface for cross-country movement in summer; poor for roads, airfields and foundations. Marked seasonal changes in soil moisture and strength.

Till. Sandy and gravelly; generally frost-susceptible, but locally non-frost susceptible. Permafrost table usually 3 or more feet below surface. Silt mantle ranges from 0 to more than 3 feet thick. Fair to poor for cross-country movement in summer; fair to good for roads and foundations. Topography normally too rough for airfields. Moderate to minor seasonal variations in soil moisture and strength.

Gravel, talus, rubble, outwash, sand, bedrock. Non-frost-susceptible. Permafrost table low, and/or permafrost does not affect surface or stability. Except where slope and roughness are limiting factors, these miscellaneous units are good to excellent for cross-country movement in summer; good to excellent for foundations for airfields, roads and buildings (except flood plains). Little or no seasonal variations in moisture and strength as far as engineering and military aspects are concerned.

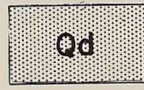
Quaternary Deposits, Undifferentiated as to Age, Resting on Glacial and Alluvial Deposits and on Bedrock



Qc, Solifluction deposits: silt and rock fragments. Mantles Delta till or bedrock hills. Solifluction deposits on bedrock hills are a mixture of angular frost-riven schist or granite; on till, similar to till, but contain more silt and are more well-graded (poorly sorted). SM. In festoons, lobes, or poorly defined terraces.



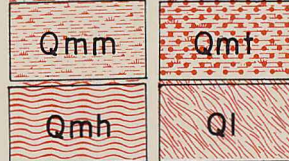
Qt, Talus. Angular boulders and smaller fragments of bedrock in fans and sheets on cirque walls and canyon sides. Large talus fans only in Granite Range.



Qd, Dune sand, mantled by silt. Medium and coarse poorly graded (well sorted) sand. SW and SP. In low sand sheets or composite dunes and sand hills, 6-20 feet thick. Sand dune field on west side of Delta River is pocked by sub-parallel depressions.



Qr, Rubble. Angular boulders and smaller fragments of bedrock resting on flat and gently inclined upland surfaces, e.g., summits of Granite Mts. or Ober Dome.

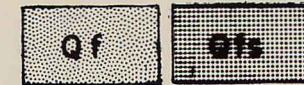


Qmm, Silt (ML) overlain by peat and marsh vegetation. Peat up to 0.5 foot thick, usually covered by standing water in summer. Permafrost 3 or more feet below peat; no micro-relief features.

Qmt, Silt (ML) overlain by peat and sedge tussocks. Peat typically 0.5 foot thick between tussocks which are commonly surrounded by water in summer. Tussocks are 1-2 feet high and 1 foot in diameter. Permafrost 2-3 feet below peat.

Qmh, Silt (ML) overlain by peat, covered by moss, sedge, and heath shrub; forming hummocks 1-2 feet high and 2-5 feet in diameter. Peat up to 1.0 foot thick.

Ql, Lake silt (ML) in drained lake basins. No micro-relief; no peat. Permafrost more than 3 feet below surface.



Qf, Flood plain gravel and sand of bare braided flood plains of glacial streams and Granite Creek. GP and GW.

Qfs, Silt and sand-covered flood plains. Channeled, covered by forest or shrub. Sand and silt 1-3 feet thick, with shallow permafrost in places. SW and SP covering GW or GP.



Qsg, Alluvial silt and sand, 2 to more than 14 feet thick, covering gravel. In younger composite terrace 3 to 8 feet above the flood plain. Permafrost in places 3 to 4 feet below surface. ML covering GW or GP.

Qss, Alluvial silt and sand, up to 15 feet thick on older composite terrace, 15 to 25 feet above flood plain. ML covering GW or GP.



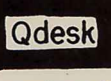
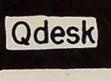
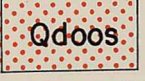
Qab, Boulderly gravel. Rounded boulders 5 or more feet in diameter in coarse sand and pebble matrix, forming boulder terrace. Surface is littered with boulders, and is channeled. Terrace rises in irregular flights to about 45 feet above flood plain. Matrix is GP.



Qaf, Alluvial fan. Sand, silt, and gravel. Silt cover up to 18 feet thick. Deeply gullied, and truncated. ML over GW or GP.



Qafc, Alluvial sand and gravel on Granite Mt. piedmont and within the mountains. Coalescent fans from alluvial and glacial sources. SW on GW or GP.



Qdot, Donnelly till. Slightly weathered, gray to yellowish sandy till with rounded and angular rock fragments. Permafrost probably 10 or more feet below surface. Mantled by 0 to 3 feet of eolian silt. Moraines are rough, with numerous kettle depressions and few bogs. 100 or more feet thick in frontal sectors. Mostly SM plus GW, GP and GM, with ML cover.

Qdotc, Donnelly till, channeled and terraced by Granite Creek.

Qdote, Donnelly till, possible early phase (?) represented by low terminal lobe in front of main moraine west of Delta River.

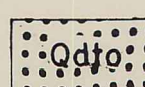
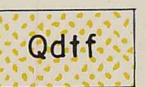
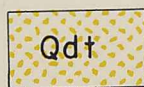
Qdoo, Donnelly outwash. Coarse gravel and sand with some silt. Well-graded (poorly sorted). Mostly GP and GW, with some SP-SM. Estimated to be at least 400 feet thick. ML cover 0 to 4 feet thick.

Qdoor, Donnelly outwash recessional phase. Silt-covered, channeled, and in places thinly mantled by till. ML covering GP, GW or SP-SM.

Qdoob, Donnelly outwash bare of silt or with silt mantle less than 0.3 foot. GW and GP.

Qdoots, Donnelly outwash with thick silt and organic silt mantle, estimated to be 10 or more feet thick. Frozen at 1 to 2 feet. ML over GP or GW.

Qdesk, Donnelly outwash esker gravel on Qdoor.



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Qdts, Delta till, mantled by eolian silt and solifluction deposits on the west slope of West Donnelly.

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Clay, sand, shale, coal, and conglomerate.



br, Crystalline bedrock: grano-diorite in the Granite Range; Birch Creek schist on Ober Dome, Donnelly Dome, and West Donnelly.

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Lithologic Data Model

	Classification		Thickness	
			Median size (mm)	Sorting coefficient
Mantle				
Underlying unconsolidated material				

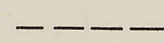
Symbols



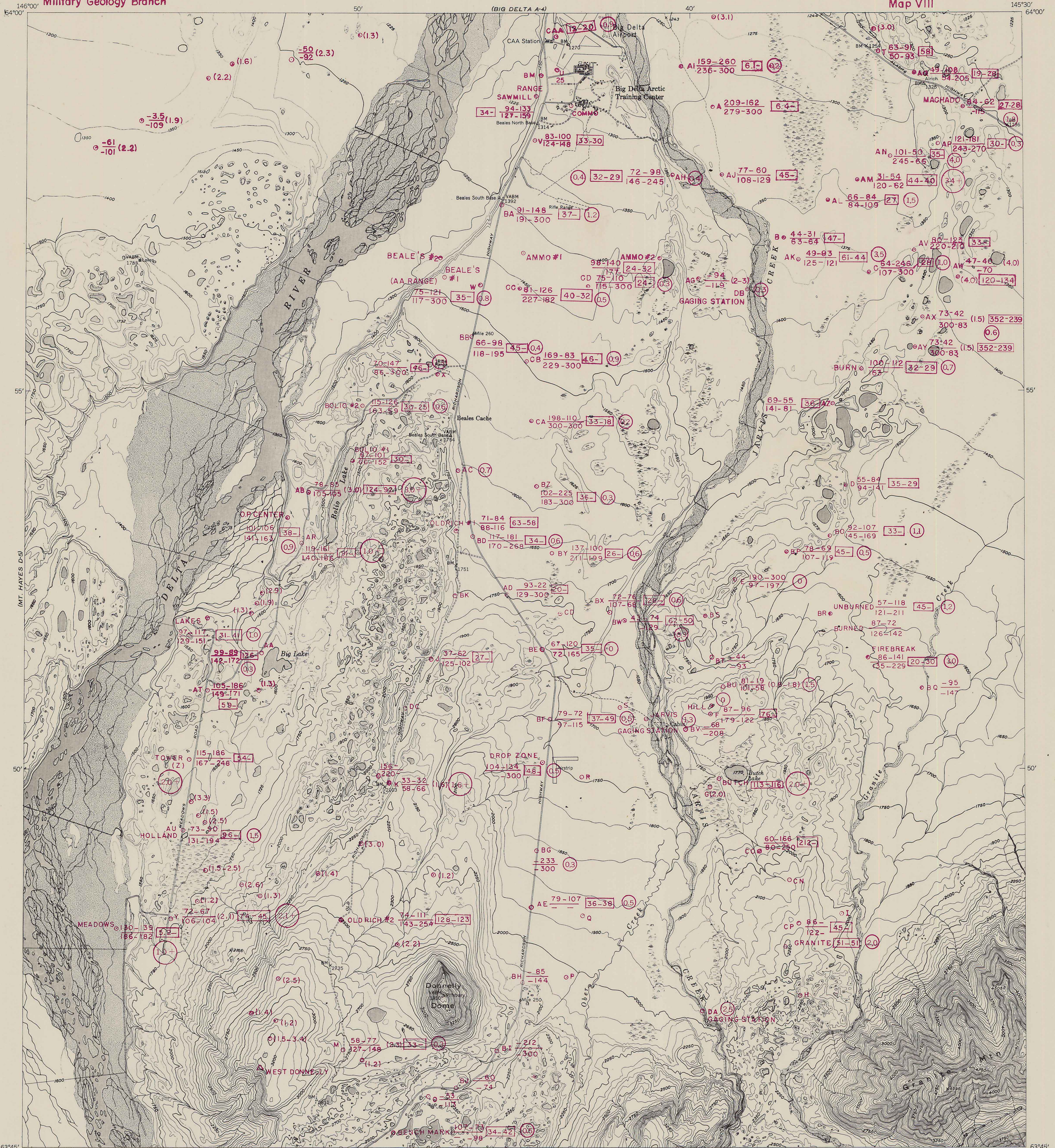
Terrace scarp



Transitional contact



Fault

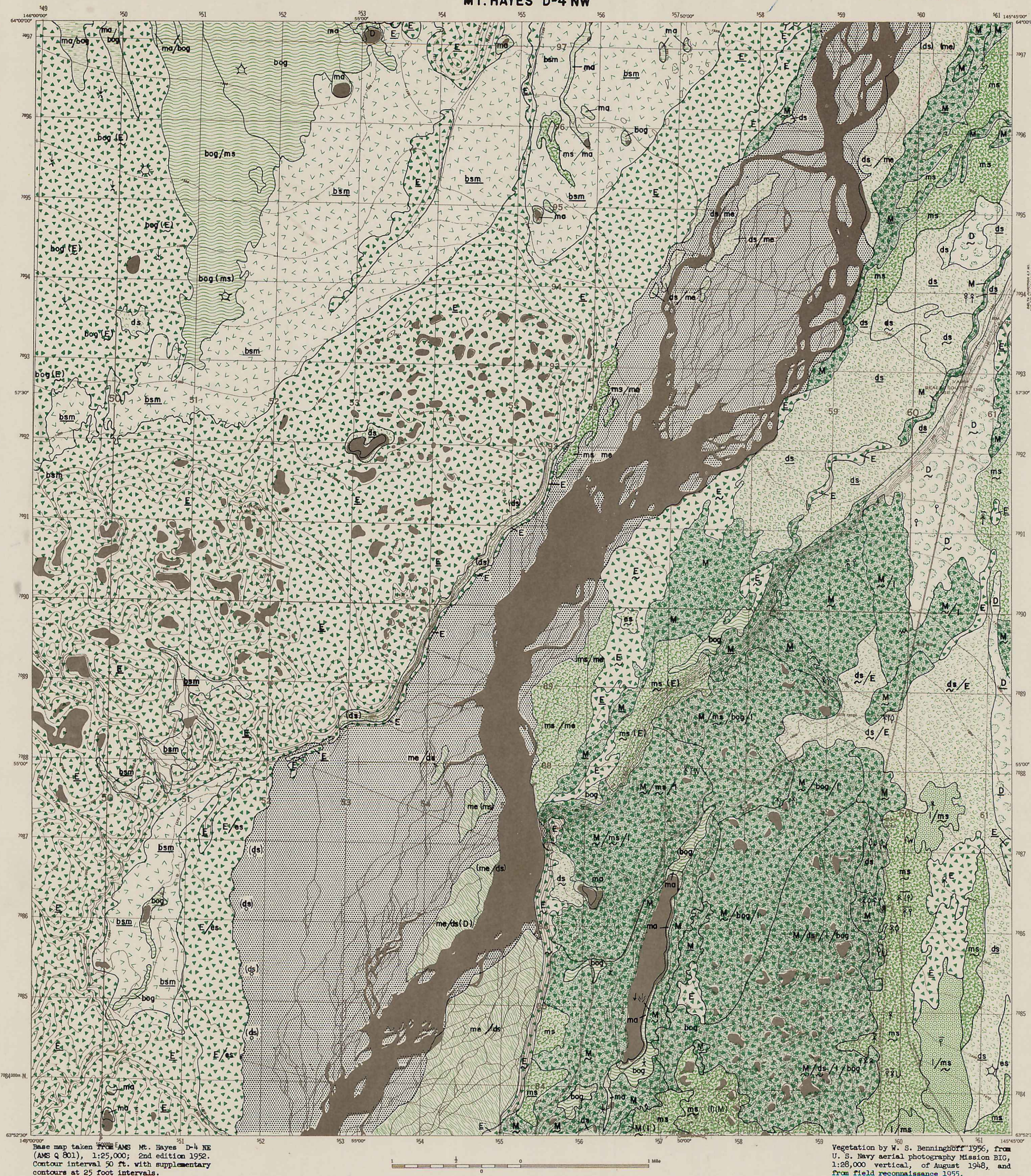


G.W. HOLMES, 1956

PENETROMETER DIAL READINGS, SOIL MOISTURE, AND DEPTH TO PERMAFROST
Mt. Hayes D-4 Quadrangle

STATION ○ A	DIAL READINGS (0 to 0.5')-Early summer - Late summer (0.5 to 1.0')-Early summer - Late summer	THICKNESS OF MANTLE (In Feet) (2.5)	DEPTH TO PERMAFROST FT. (Ft.)	SOIL MOISTURE %
				Early summer - Late summer
				Data not available for all stations.

NOTE: All but 3 penetrometer stations mantled by silt or sand. Many, as indicated, have mantle less than a foot thick, covering till, outwash or alluvium. For thickness at other stations, see maps IV - A, B, C, and D.

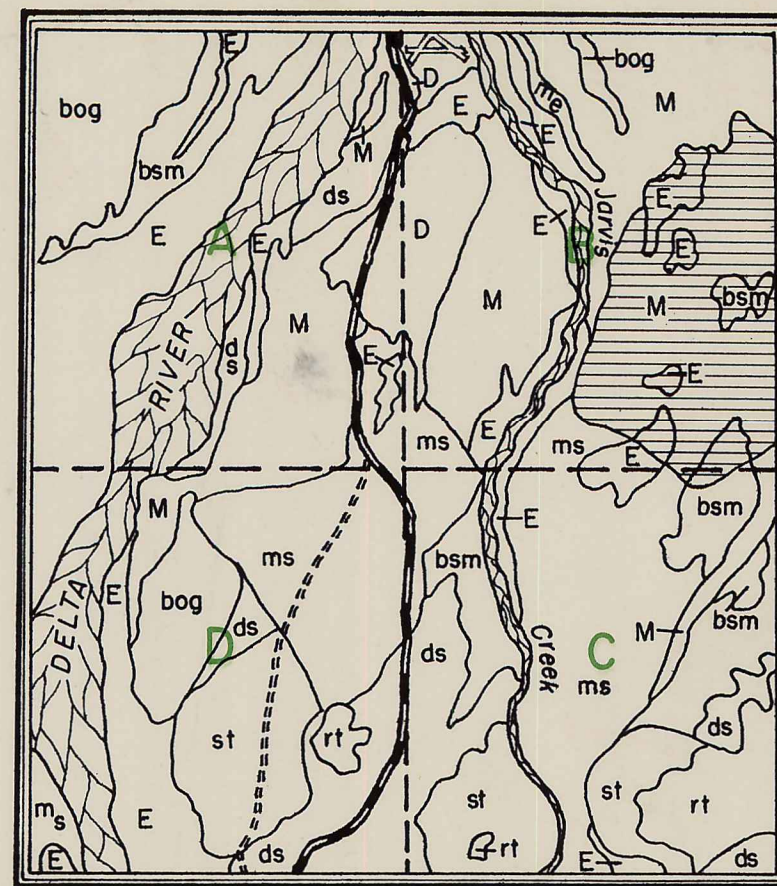


Base map taken from AMS Mt. Hayes D-4
(AMS Q801), 1:25,000, 2nd edition, 1952.

Mapped by W. S. Benninghoff, 1956, from
U.S. Navy aerial photography, Mission BIG,
1:25,000 vertical, of August 1948, and
from field reconnaissance, 1955.

MAP UNITS

NOTE: In some localities vegetation units overlap the water tint of the Delta River, indicating a change in the channel courses by 1949 when the base map photography was flown. Water tint of certain lakes is overlapped by vegetation units, for the most part bog or marsh, indicating areas intermittently inundated.



INDEX MAP

Vegetation structure:

- M Dense stand (of mixed evergreen--deciduous forest); trees no farther apart than average height.
- M Open stand (of mixed evergreen--deciduous forest); trees farther apart than average height.
- M Stand of variable density (mixed evergreen--deciduous forest); some trees farther apart than average height, others closer than average height.
- / Used between 2 unit symbols to indicate that those 2 vegetation units occur intermingled in patterns too small to map at this scale. The first (left) symbol determines map unit pattern.
- () Vegetation represented by symbol in parentheses occurs as an unmappable inclusion within the map unit indicated to the left of the parenthesis.
- ↑ Tree (e.g., black spruce) less than 6 feet tall.
- ⬆ Isolated individuals (of white spruce) as inclusions within a map unit.
- ☆ Polygonal patterns in vegetation.
- Stripe patterns in vegetation.
- ↗ Orientation of wind-formed patterns in vegetation (arrow points downwind).

Composition (used only to record field observations):

↑ White spruce	⬆ White birch	× Juniper
↑ Black spruce	⬆ Aspen	⬆ Alder
↑ Larch	⬆ Balsam poplar	⬆ Willow
↑ Glandular birch	⬆ Grass	mm Mosses
↑ Dwarf birch	⬆ Tall grass	mm Sphagnum moss
↑ Heath shrub	⬆ Sedge	mm Lichens
⬆ Tussock-forming sedge	⬆ Dense aquatic vegetation	
Extent of "Granite Mountain Burn", a forest fire of August 1954.		

FOREST

Plant communities in which trees (tree species more than 6 feet tall) are a dominant growth form.

- E** Evergreen forest. Composed of needle-leaved, evergreen, coniferous trees (white spruce and black spruce).
- M** Mixed evergreen--deciduous forest. composed of both evergreen coniferous trees and deciduous broad-leaved trees, the smaller components constituting at least 10 percent of the trees. In Tanana Valley includes some larch (deciduous needle-leaved conifer).
- D** Deciduous forest. Composed of deciduous broad-leaved trees (white birch, aspen, balsam poplar). Includes willows of tree stature.

SCRUB and/or SHRUB

Plant communities in which woody plants 1 - 6 feet tall are primary components; includes scrub (tree species less than 6 feet tall) and/or shrubs (low, woody, bushy plants, usually with multiple stem axes).

- es** Evergreen scrub. White spruce or black spruce trees either in young stands or stunted (as those near the altitudinal limit of trees).
- ms** Mixed evergreen--deciduous scrub and/or shrub. Young white spruce or black spruce mixed with deciduous scrub and/or shrub.
- ds** Deciduous scrub and/or shrub. Deciduous scrub (young, stunted, or severely browsed deciduous trees) and/or shrubs (willows, alders, glandular birch, and heath shrubs).

TUNDRA

Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

- st** Shrub tundra. Matted or tussocky turf of mosses, lichens, small sedges and grasses, and forbs, in which low or creeping or mat-like shrubs are rooted.
- rt** Rock desert. Incomplete cover consisting of mosses and lichens (in mats or cushions), sedges and grasses (in tufts), forbs (in rosettes or cushions) and shrubs (low, creeping or matted).

MEADOW

Plant communities primarily of herbaceous forms (grasses, sedges, and erect forbs), producing a lawn, sod, or fibrous turf.

- me** Meadow. Grasses and erect forbs, sometimes with thin soil cover of lichens and mosses; luxuriance varies from sparse lawn to tall lush hay meadow.
- ma** Marsh. Sedges, and less commonly grasses, in relatively uniform stands on wet or seasonally inundated sites; forms heavy sod or fibrous turf that usually is waterlogged.

bsm

Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

bog

Bog. Nearly continuous ground cover of mosses in which characteristic low shrubs (heath shrubs, glandular birch, dwarf birch, crowberry) and/or sedges and a few species of grasses are rooted; humus beneath the ground cover perennially waterlogged.

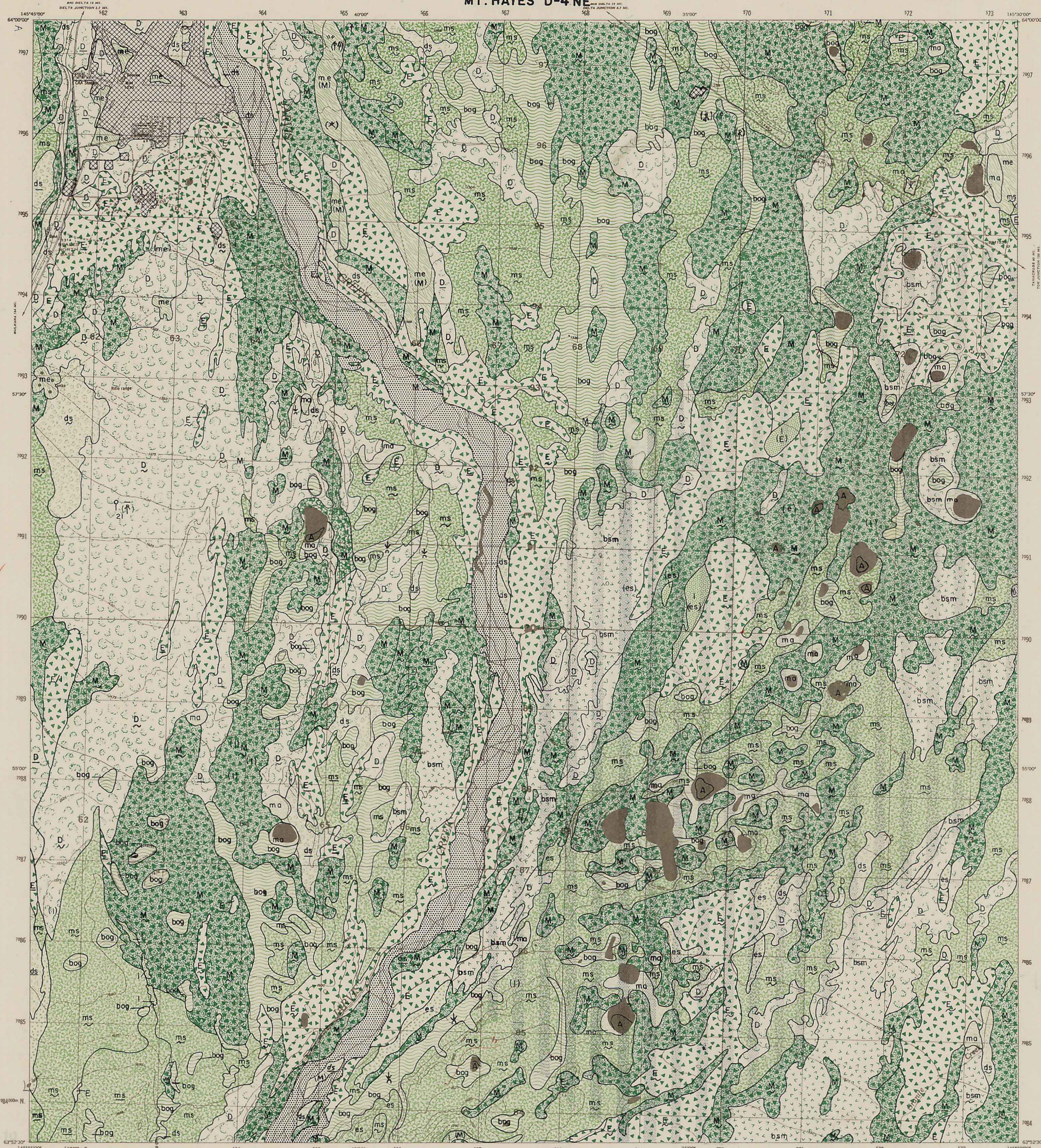
VEGETATION OF LOCAL SIGNIFICANCE

- I** Lichen barrens. Plant communities of fruitcose (and in places including some crustose) lichens, forming incomplete cover on gravel surfaces; locally accompanied by scattered mat shrubs (bearberry) or tufted plants (small grasses, etc.).
- A** Aquatic communities. Submersed vegetation (Nitella, bladderwort, pondweeds, etc.) and emergent vegetation (water knotweed, yellow pond lily, etc.) in localities observed on the ground or where aquatic vegetation could be observed in aerial photographs.

AREAS NOT MAPPED WITH RESPECT TO VEGETATION

- Barren flood plain areas.** Areas on flood plains where no significant vegetation was observed.
- Areas disturbed by culture.** No significant vegetation present (bare areas) or patterns too complex to map at this scale.

VEGETATION
MT. HAYES D-4 NE

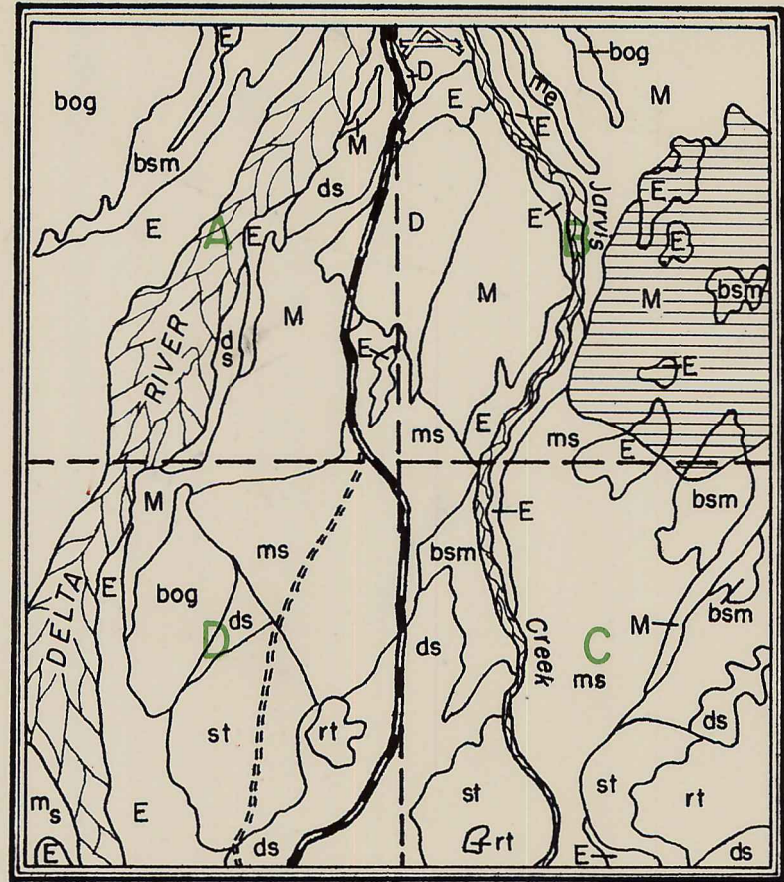


Base map taken from AMS Mt. Hayes D-4
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- ☆** Polygonal patterns in vegetation.
- Stripe patterns in vegetation.
- ↑** Orientation of wind-formed patterns in vegetation (arrow points downwind).

Composition (used only to record field observations):

- | | | |
|-------------------------|-----------------|----------------------------|
| ↑ White spruce | ↑ White birch | × Juniper |
| ↑ Black spruce | ↑ Aspen | U Alder |
| ↑ Larch | ↑ Balsam poplar | w Willow |
| ↑ Glandular birch | ↓ Grass | mm Mosses |
| ↑ Dwarf birch | ↓ Tall grass | mm Sphagnum moss |
| ↑ Heath shrub | ↓ Sedge | mm Lichens |
| ↑ Tussock-forming sedge | | A Dense aquatic vegetation |
- Extent of "Granite Mountain Burn", a forest fire of August 1954.

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Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

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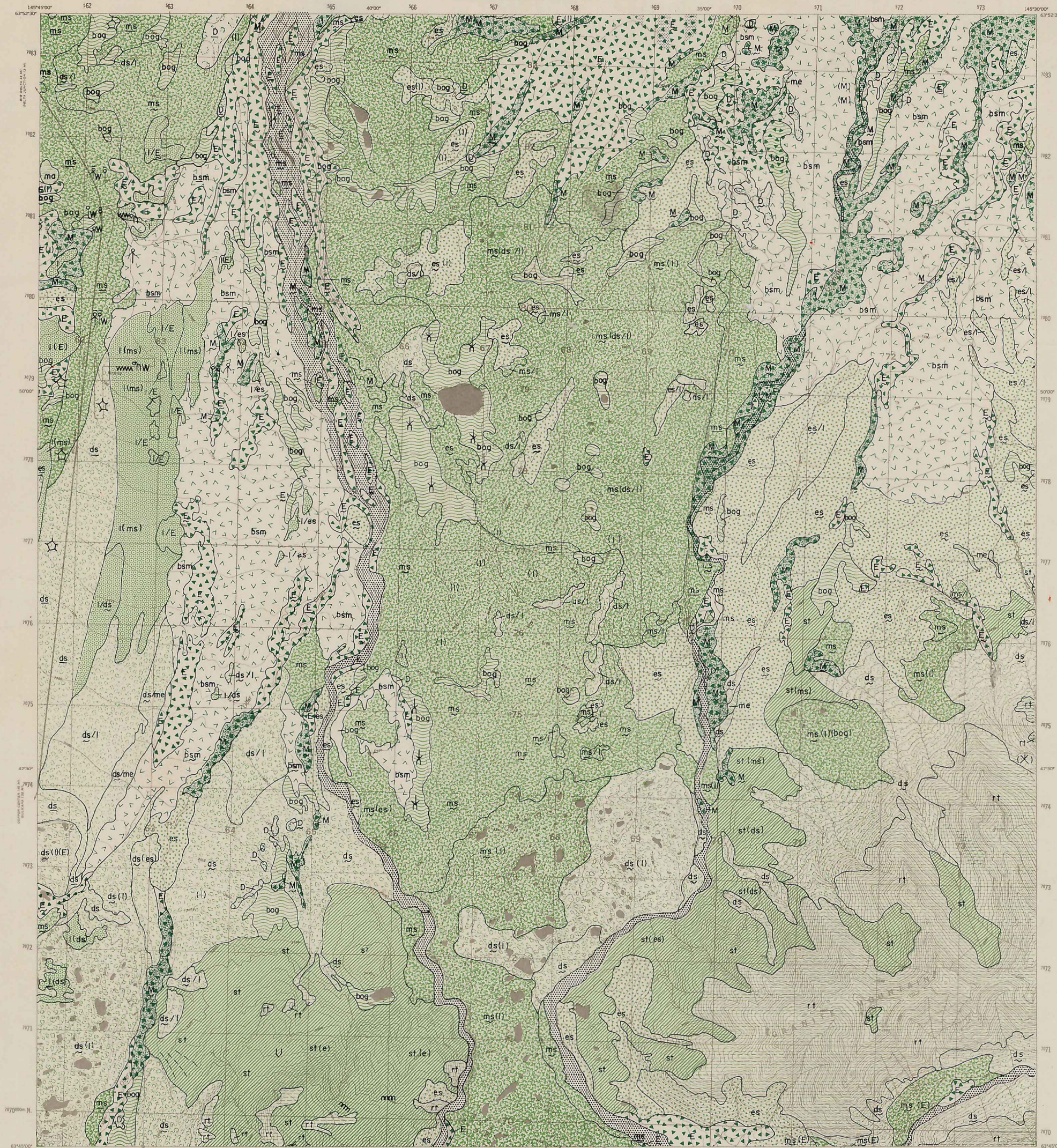
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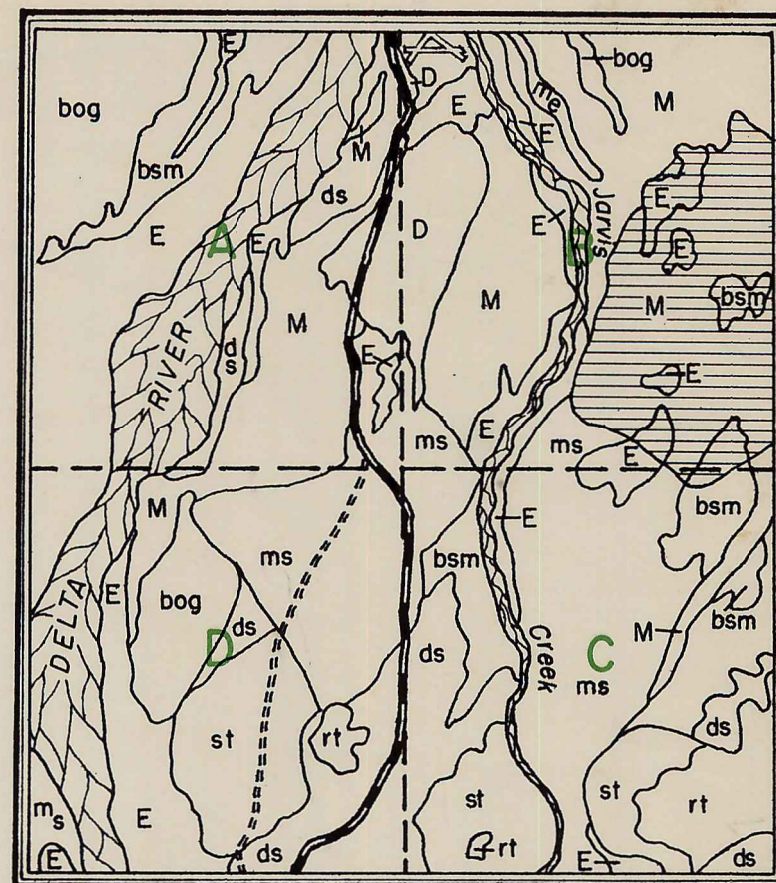
Base map taken from AMS Mt. Hayes D-4
(AMS Q 801), 1:25,000, 2nd edition, 1952.

Mapped by W. S. Benninghoff, 1956, from
U.S. Navy aerial photography, Mission BIG,
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from field reconnaissance, 1955.

Vegetation by W. S. Benninghoff 1956, from
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- | | | |
|-----------------|-----------------------|--------------------------|
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| Larch | Balsam poplar | Willow |
| Glandular birch | Grass | Mosses |
| Dwarf birch | Tall grass | Sphagnum moss |
| Heath shrub | Sedge | Lichens |
| | Tussock-forming sedge | Dense aquatic vegetation |
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Plant communities in which trees (tree species more than 6 feet tall) are a dominant growth form.

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M Mixed evergreen--deciduous forest. composed of both evergreen coniferous trees and deciduous broad-leaved trees, the smaller components constituting at least 10 percent of the trees. In Tanana Valley includes some larch (deciduous needle-leaved conifer).

D Deciduous forest. Composed of deciduous broad-leaved trees (white birch, aspen, balsam poplar). Includes willows of tree stature.

bsm Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

SCRUB and/or SHRUB

Plant communities in which woody plants 1 - 6 feet tall are primary components; includes scrub (tree species less than 6 feet tall) and/or shrubs (low, woody, bushy plants, usually with multiple stem axes).

es Evergreen scrub. White spruce or black spruce trees either in young stands or stunted (as those near the altitudinal limit of trees).

ms Mixed evergreen--deciduous scrub and/or shrub. Young white spruce or black spruce mixed with deciduous scrub and/or shrub.

ds Deciduous scrub and/or shrub. Deciduous scrub (young, stunted, or severely browsed deciduous trees) and/or shrubs (willows, alders, glandular birch, and heath shrubs).

TUNDRA

Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

st Shrub tundra. Matted or tussocky turf of mosses, lichens, small sedges and grasses, and forbs, in which low or creeping or mat-like shrubs are rooted.

rt Rock desert. Incomplete cover consisting of mosses and lichens (in mats or cushions), sedges and grasses (in tufts), forbs (in rosettes or cushions) and shrubs (low, creeping or matted).

bog Bog. Nearly continuous ground cover of mosses in which characteristic low shrubs (heath shrubs, glandular birch, dwarf birch, crowberry) and/or sedges and a few species of grasses are rooted; humus beneath the ground cover perennially waterlogged.

MEADOW

Plant communities primarily of herbaceous forms (grasses, sedges, and erect forbs), producing a lawn, sod, or fibrous turf.

me Meadow. Grasses and erect forbs, sometimes with thin soil cover of lichens and mosses; luxuriance varies from sparse lawn to tall lush hay meadow.

md Marsh. Sedges, and less commonly grasses, in relatively uniform stands on wet or seasonally inundated sites; forms heavy sod or fibrous turf that usually is waterlogged.

VEGETATION OF LOCAL SIGNIFICANCE

I Lichen barrens. Plant communities of fruitcose (and in places including some crustose) lichens, forming incomplete cover on gravel surfaces; locally accompanied by scattered mat shrubs (bearberry) or tufted plants (small grasses, etc.)

A Aquatic communities. Submersed vegetation (Nitella, bladderwort, pondweeds, etc.) and emergent vegetation (water knotweed, yellow pond lily, etc.) in localities observed on the ground or where aquatic vegetation could be observed in aerial photographs.

AREAS NOT MAPPED WITH RESPECT TO VEGETATION

Barren flood plain areas. Areas on flood plains where no significant vegetation was observed.

Areas disturbed by culture. No significant vegetation present (bare areas) or patterns too complex to map at this scale.

VEGETATION
MT. HAYES D-4 SW

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IX-D

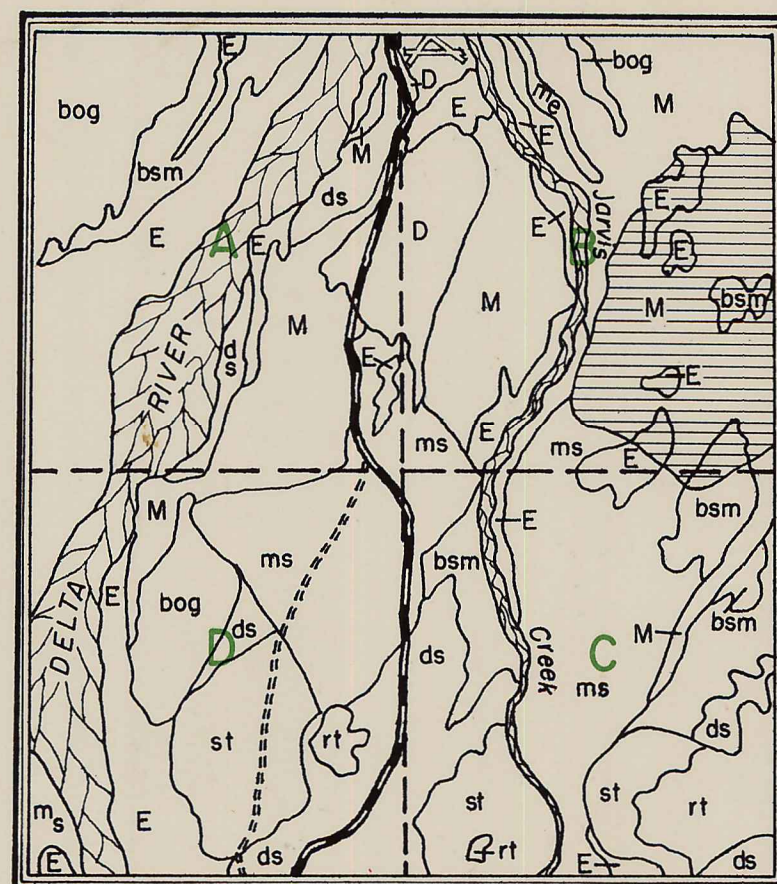


Base map taken from AMS Mt. Hayes D-4
(AMS Q801), 1:25,000, 2nd edition, 1952.

Mapped by W. S. Benninghoff, 1956, from
U.S. Navy aerial photography, Mission BIG,
1:25,000 vertical, of August 1948, and
from field reconnaissance, 1955.

MAP UNITS

NOTE: In some localities vegetation units overlap the water tint of the Delta River, indicating a change in the channel courses by 1949 when the base map photography was flown. Water tint of certain lakes is overlapped by vegetation units, for the most part bog or marsh, indicating areas intermittently inundated.



INDEX MAP

Vegetation structure:

- M Dense stand (of mixed evergreen--deciduous forest); trees no farther apart than average height.
- M Open stand (of mixed evergreen--deciduous forest); trees farther apart than average height.
- M Stand of variable density (mixed evergreen--deciduous forest); some trees farther apart than average height, others closer than average height.
- / Used between 2 unit symbols to indicate that those 2 vegetation units occur intermingled in patterns too small to map at this scale. The first (left) symbol determines map unit pattern.
- () Vegetation represented by symbol in parentheses occurs as an unmappable inclusion within the map unit indicated to the left of the parenthesis.
- Tree (e.g., black spruce) less than 6 feet tall.
- Isolated individuals (of white spruce) as inclusions within a map unit.
- Polygonal patterns in vegetation.
- Stripe patterns in vegetation.
- Orientation of wind-formed patterns in vegetation (arrow points downwind).

Composition (used only to record field observations):

- | | | |
|-----------------------|---------------|--------------------------|
| White spruce | White birch | Juniper |
| Black spruce | Aspen | Alder |
| Larch | Balsam poplar | Willow |
| Glandular birch | Grass | Mosses |
| Dwarf birch | Tall grass | Sphagnum moss |
| Heath shrub | Sedge | Lichens |
| Tussock-forming sedge | | Dense aquatic vegetation |
- Extent of "Granite Mountain Burn", a forest fire of August 1954.

FOREST

Plant communities in which trees (tree species more than 6 feet tall) are a dominant growth form.

- E** Evergreen forest. Composed of needle-leaved, evergreen, coniferous trees (white spruce and black spruce).
- M** Mixed evergreen--deciduous forest. composed of both evergreen coniferous trees and deciduous broad-leaved trees, the smaller components constituting at least 10 percent of the trees. In Tanana Valley includes some larch (deciduous needle-leaved conifer).
- D** Deciduous forest. Composed of deciduous broad-leaved trees (white birch, aspen, balsam poplar). Includes willows of tree stature.

SCRUB and/or SHRUB

Plant communities in which woody plants 1 - 6 feet tall are primary components; includes scrub (tree species less than 6 feet tall) and/or shrubs (low, woody, bushy plants, usually with multiple stem axes).

- es** Evergreen scrub. White spruce or black spruce trees either in young stands or stunted (as those near the altitudinal limit of trees).
- ms** Mixed evergreen--deciduous scrub and/or shrub. Young white spruce or black spruce mixed with deciduous scrub and/or shrub.
- ds** Deciduous scrub and/or shrub. Deciduous scrub (young, stunted, or severely browsed deciduous trees) and/or shrubs (willows, alders, glandular birch, and heath shrubs).

TUNDRA

Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

- st** Shrub tundra. Matted or tussocky turf of mosses, lichens, small sedges and grasses, and forbs, in which low or creeping or mat-like shrubs are rooted.
- rt** Rock desert. Incomplete cover consisting of mosses and lichens (in mats or cushions), sedges and grasses (in tufts), forbs (in rosettes or cushions) and shrubs (low, creeping or matted).

MEADOW

Plant communities primarily of herbaceous forms (grasses, sedges, and erect forbs), producing a lawn, sod, or fibrous turf.

- me** Meadow. Grasses and erect forbs, sometimes with thin soil cover of lichens and mosses; luxuriance varies from sparse lawn to tall lush hay meadow.
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bsm Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

bog Bog. Nearly continuous ground cover of mosses in which characteristic low shrubs (heath shrubs, glandular birch, dwarf birch, crowberry) and/or sedges and a few species of grasses are rooted; humus beneath the ground cover perennially waterlogged.

VEGETATION OF LOCAL SIGNIFICANCE

- I** Lichen barrens. Plant communities of fruitcose (and in places including some crustose) lichens, forming incomplete cover on gravel surfaces; locally accompanied by scattered mat shrubs (bearberry) or tufted plants (small grasses, etc.)
- A** Aquatic communities. Submersed vegetation (Nitella, bladderwort, pondweeds, etc.) and emergent vegetation (water knotweed, yellow pond lily, etc.) in localities observed on the ground or where aquatic vegetation could be observed in aerial photographs.

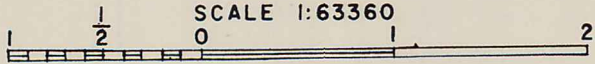
AREAS NOT MAPPED WITH RESPECT TO VEGETATION

- Barren flood plain areas.** Areas on flood plains where no significant vegetation was observed.
- Areas disturbed by culture.** No significant vegetation present (bare areas) or patterns too complex to map at this scale.

CROSS - COUNTRY MOVEMENT

Mt. Hayes D-4

SCALE 1:63360



Terrain study of the Army Test Area
Fort Greely, Alaska
Map XIII

U. S. Department of the Interior
Geological Survey
Military Geology Branch

SPECIAL SYMBOLS

Roadway or trail cut through impassable area.

Fairly good unprepared route in rough terrain; ease of movement equal in both directions.

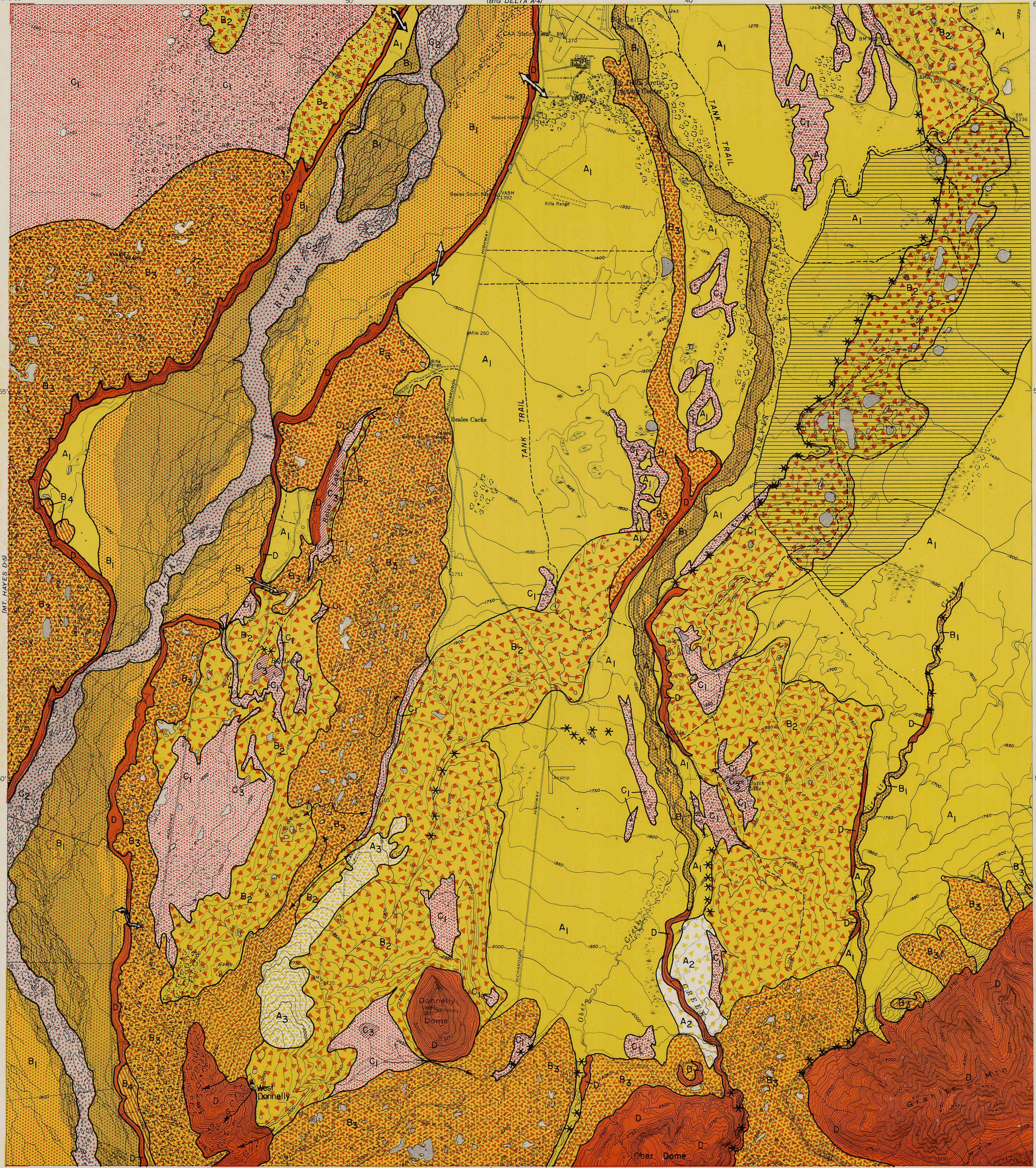
Possible unprepared one-way route in rough or impassable area.

Trail.

Very dense forest. Stands of trees (most commonly spruce) with trunks 3-10 inches d.b.h. and spaced less than 10 feet apart.

Areas of deep snow. Snow accumulation commonly 2-6 feet deeper than elsewhere in Fort Greely area.

Area of 1954 burn. Almost bare ground, as result of 1954 fire. Charred spruce and aspen poles falling to ground; and willows, aspen, and herbaceous plants growing up in the area.



Base map Geological Survey 1:63,360 series (Topographic), Mt. Hayes (D-4) Quadrangle, Alaska, edition of 1952.

Legend Analysis and Evaluation of Cross-Country Movement in the Test Area accompanies Map XIII

Cross-Country Movement Evaluation by G. W. Holmes, 1956.

EXPLANATION

PASSABLE AT ALL SEASONS *

- A1** Some moraine surfaces; outwash plains; younger composite terrace; portions of older composite terrace; coalescent alluvial fans of Granite Mts.
- A2** Boulder terrace.
- A3** Moraine-covered surface of West Donnelly Hill.

LOCALLY IMPASSABLE IN ONE OR MORE SEASONS *

- B1** Flood plains and channels of Jarvis Creek and Granite Creek.
- B2** Most Delta moraines; sections of Donnelly moraines; Donnelly recessional outwash plains of Big Lake; dune-covered older composite terrace south.
- B3** Most Donnelly moraines; parts of Delta moraines.
- B4** Individual alluvial fans and older composite terrace.

ENTIRE UNIT IMPASSABLE IN ONE OR MORE SEASONS *

- C1** Large bogs, muskegs, and marshes.
- C2** Delta River.
- C3** Lakes.

IMPASSABLE AT ALL SEASONS *

- D** Bedrock hills; Granite Mts.; stream bluffs; narrow or boulder-choked valleys.

* General evaluation is basis of map units, and refers to feasibility of cross-country movement by a tactical unit which includes tanks, light tracked vehicles, and foot soldiers.

GENERAL EVALUATION *	MAP UNITS		PERSISTENT GROUND CONDITIONS AFFECTING CROSS-COUNTRY MOVEMENT		SEASONAL CONDITIONS AFFECTING CROSS-COUNTRY MOVEMENT				VEGETATION AFFECTING CROSS-COUNTRY MOVEMENT			Seasons of movement **	EVALUATION BY SEASONS ***			
	Symbol	Diagnostic landforms			Summer	Freeze-up	Winter	Break-up					Summer	Freeze-up	Winter	Break-up
Passable at all seasons	A ₁	Some moraine surfaces; outwash plains; younger composite terrace; portions of older composite terrace; coalescent alluvial fans of Granite Mts.	Level,	No important irregularities.	Firm, relatively dry surfaces, except for a few small bogs and muskegs.	Firm dry surfaces.	Snow cover relatively uniform. Rarely more than 1.5 feet. Snow-free in places exposed to wind.	Soft snow, slush, sheet floods, running water in gullies. Ground firm.	Small dense stands of larger spruce on terrace east of Fort Greely. Wide-spread forest of medium-size trees hindering movement. Local small thickets; tangles of fallen timber in burn areas.	Medium tracked Light tracked Foot	P P P	P P P	P P S	P P S		
	A ₂	Boulder terrace.	gently sloping or	Irregular swales 5-10 feet deep on terrace.	Firm dry surfaces, boulders up to 7 feet diameter exposed.	Snow cover partly hides boulders.	Soft snow, slush, many boulders exposed. Water in swales. Ground firm.	No hindrance by vegetation.	Medium tracked Light Foot	S S P	S S P	S S S	S S S			
A ₃	Moraine-covered surface of West Donnelly Hill.	very gently	Broad solifluction terraces permafrost at shallow depth.	Pits and hummocks exposed, locally boggy, generally firm.	Thin snow over generally firm ground, locally saturated.	Snow cover, strength, and thickness variable.	Soft snow, slush, small rills. Ground firm.	No hindrance by vegetation. No hindrance by vegetation. (Frost scars and solifluction lobes scarce partially concealed by shrubs.) No hindrance by vegetation.	Medium tracked Light tracked Foot	P S S	P S S	P P S	P S S			
Locally impassable in one or more seasons	B ₁	Flood plains and channels of Jarvis Creek and Granite Creek.	rolling	Shallow abandoned channels - maximum depth 3-5 feet.	Firm dry gravel surfaces. Migrating sand dunes. Driftwood. Numerous channels. Boulders in places.	Firm dry gravel surfaces. Few narrow, deep channels. Thin icings; boulders exposed in places.	Uneven icings. Snow-covered in places. Open channels or thin ice on channels.	Soft snow, slush, weak channel ice and icings, floods in some sections. Many channels. Gravel firm.	Except for driftwood, no hindrance by vegetation on gravel-covered sections.	Silt and sand-covered sections: Dense stands of large spruce Dense stands of mixed forest and scrub. Local thickets.	Medium tracked Light tracked Foot	P S, L P, L	P, L S, L P, L	P, L S, L S, L		
	B ₂	Most Delta moraines; sections of Donnelly moraines; Donnelly recessional outwash plains of Big Lake; dune-covered older composite terrace.	Rough topography;	Moderate slopes typically 5-10 percent, rarely more than 30 percent; approximately 1-5 hill summits or depressions and 2 bogs per square mile.	Firm dry ridges and summits; muskegs on some lower slopes; bogs, marshes, muskegs, and ponds in depressions.	Same as summer, except bogs, marshes, muskegs more difficult when partly frozen.	Snow cover non-uniform; deep drifts in lee of knobs, ridges, ponds, bogs; wind-hardened drifts.	Soft snow, slush; pond ice soft; bogs, marshes flooded. Hill tops and ridges may be firm if bare in winter. Ground firm.	No important hindrances to medium tracked vehicles. Large portions recently burned. Elsewhere below timberline dense to variable density forest and scrub. No important hindrances to foot travel, a few local shrub thickets.	Medium tracked Light tracked Foot	P, L P, L P, L	P, L P, L P, L	P S S	S, L S, L S, L		
B ₃	Most Donnelly moraines; parts of Delta moraines.	closely spaced hills, ridges,	Slopes typically 10-20 percent, rarely more than 60 percent; approximately 5-15 hill summits or depressions and 1 bog per square mile.	Same as B ₂ unit, except bogs smaller, fewer, ponds more numerous. Boulders exposed on ridges. West Donnelly west slopes silt-covered.	Same as summer, except bogs, marshes, muskegs more difficult when partly frozen.	Snow cover non-uniform; deep drifts in lee of knobs, ridges, ponds, bogs; wind-hardened drifts. Snow partly covers boulders.	Soft snow, slush; pond ice soft. Drainage not developed; local ponding. Bogs, marshes flooded; hill tops and ridges may be firm if bare in winter. Ground firm.	Dense stands of large spruce west of Delta River on West Donnelly, and along east bank of Delta River. Locally dense mixed and evergreen forest. Local shrub thickets.	Medium tracked Light tracked Foot	S, L S, L S, L	S, L S, L P, L	S S S	S, L S, L S, L			
B ₄	Individual alluvial fans and older composite terrace.	Depressions, or gullies	Narrow, steep-sided gullies 40 feet or less in depth.	No irregularities on inter-stream surfaces. Thick silt, low bearing strength when wet.	Same as summer.	Snow cover uniform on inter-stream surfaces. Some gullies drifted over.	Soft snow, slush, ponding, but ground firm.	Dense stands of large spruce. Dense stands of large spruce. No hindrances to foot travel.	Medium tracked Light tracked Foot	P, L P, L S	P, L P, L S	S, L S, L S, L	S, L S, L S, L			
Entire unit impassable in one or more seasons	C ₁	Large bogs, muskegs, and marshes.	Fibrous, compressible vegetation mat; thin peat over silt with high moisture content. Permafrost 2-4 feet below surface.	Uneven surface in hummock and tussock bogs and muskegs. Low bearing strength and poor traction.	Same as summer. More difficult when surface is frozen and subsurface is still thawed.	Uneven to smooth snow-covered surfaces depending on exposure to wind and snowfall.	Soft snow, slush, ponding, but ground is firm.	No hindrances by shrub or scrub. Plant parts lodge easily around tracks and suspension systems. No hindrances by shrub or scrub. Plant parts lodge easily around tracks and suspension systems. Tussocks and hummocks slow foot travel.	Medium tracked Light tracked Foot	ItoS P S	ItoS P S	P P S	S S S			
	C ₂	Delta River.	On broad flood plain, exposed to winds. Inclosed by steep, high bluffs; location on flood plain shown is generalized. River channels frequently shift.	Many channels, all sizes up to 15 feet deep, shifting and changing shape.	Few channels. Some fordable. Thin channel ice and icings.	Broad icings, irregular snow cover, uneven surface, open channels; ice up to 3 feet thick.	Soft snow, persistent icings, open channels widely distributed.	No hindrance by vegetation. No hindrance by vegetation. No hindrance by vegetation.	Medium tracked Light tracked Foot	I I I	ItoS I I	S, L S, L S, L	I I I			
C ₃	Lakes.	Inclosed by gentle to steep slopes; rarely connected to streams.	Open water. Most ponds 4 feet deep.	Thin ice, thin snow.	Uniform strong ice typically 3 feet thick. Snow cover depends on wind exposure.	Soft snow and weak ice.	No hindrances by vegetation. Pond borders marshy or boggy. No hindrances by vegetation. Pond borders marshy or boggy. No hindrances by vegetation. Pond borders marshy or boggy.	Medium tracked Light tracked Foot	I I I	I I I	P P P	I I I				
Impassable at all seasons	D	Bedrock Hills; Granite Mountains; stream bluffs; narrow or boulder-choked valleys.	Includes slopes from 60 percent to vertical.	Surface uneven because of talus, solifluction deposits, pits, gullies and rubble, alluvial fans, alluvium, and ground moraine.	Same as summer, with possibility of uneven snow cover.	Uneven snow cover depending on slope, exposure, elevation.	Soft snow, slush; rapid runoff in gullies and streams.	Local shrub and scrub thickets and small stands of dense forest. Local shrub and scrub thickets and small stands of dense forest. Local shrub and scrub thickets and small stands of dense forest.	Medium tracked Light tracked Foot	I I S	I I S	I I S, L	I I S, L			

* General evaluation is basis of map units and refers to feasibility of cross-country movement by a tactical unit, which includes medium tanks, light tracked vehicles, and foot soldiers.

** Medium tracked refers to medium tanks and equivalent. Light tracked refers to vessels, otters or equivalent. Foot includes ski and snowshoe travel.

*** P - Passable
I - Impassable
S - Passable, slow
L - Impassable locally